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Studies Upon Injuries of the Kidney, Nephrolithotomy and Nephrorraphy.

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WITH COMPLIMENTS OF THE AUTHOR



STUDIES UPON INJURIES OF THE KIDNEY,
NEPHROLITHOTOMY AND NEPHRORRAPHY.

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IN THE preface of this paper the author wishes to state that the succeeding lines are intended as an additional contribution, rather than a complete study upon the momentous subjects indicated in its title.

At the outset I wish to acknowledge my obligations to Dr. B. H. Lammers, Dr. Eiseman (D. V. S.), Mr. Joseph Coomes, and others, for their invaluable assistance which has been freely given me in my work.

In this contribution it has been my endeavor to add to our knowledge concerning these affections with the hope of increasing the chances of saving this organ in conditions which formerly might have demanded its removal.

The import of this necessity is most keenly felt, when we remember their significance as the most important emunctories in the human economy.

While life itself may continue apparently unaffected after the loss of a kidney, it nevertheless seems within the pale of logic to regard such a loss as proportionally increasing the chances of future difficulty from over-taxation, not to speak of the gravity which would attend the presence of a condition demanding surgical interference upon the remaining organ.

It is frequently a difficult matter to draw a hard line between the relative bearing which the physician and the surgeon have toward many of the pathological processes of this organ, to decide when and which are medical or surgical cases.

The text of this article is based upon an analysis of the present literature upon the subject, together with a few observations drawn from the post-mortem table and a moderate amount of experimental investigation.

It was my intention to have dwelt upon nephrolithotomy and nephrorrhaphy as thoroughly as upon the injuries of the kidney but time and space defeated this end.

This is all the more to be regretted since certain sections, especially upon nephrolithotomy, are perhaps of the greatest moment to the surgeon.

The original intent was not only altered in this respect, but it became necessary for the same reason to at least temporarily abandon a series of experiments embodying some possible improvements upon a subject closely related to the one under consideration.

In carrying out these experimental operations due regard was attached to cleanliness. The operative field was thoroughly scrubbed with soap and warm water and finally irrigated with a sublimate (1x1500) or a carbolyzed solution.

Throughout the operation the neighboring space was carefully protected with towels wrung from a warm sublimate solution.

Where irrigation was resorted to within the cavity, either warm Thiersch's solution or boiled water was employed. The animals were selected irrespective of their size or condition and submitted to no preliminary preparation other than anæsthetization.

For the latter purpose both ether and chloroform were employed. The former was invariably employed to commence the anæsthesia, which was afterward continued with chloroform cautiously administered.

The animals were fed upon finely chopped meat or upon milk. However slight the operation may have been, they ate little or nothing, as a rule, upon the following day.

Unless otherwise indicated, the kidneys were exposed through an incision made into the loin commencing immediately below the ribs, running parallel with and a short distance from the spine. While such an incision afforded an admirable access to the kidney, it was nevertheless far from being as

desirable as one in the linea alba, since the peculiar position of the subject, at best afforded a miserable provision for drainage, and was in a few instances the cause of infecting the interior.

The incisions were closed by a double row of sutures, inverting the flaps at the lower angle as a provisional step toward securing drainage. The union in all but two instances was by slow granulation.

In the excepted cases primary union was obtained. As for suture material, silk, prepared after the precepts of Czerny, was generally employed for internal work. For closing the entrance wound linen thread (Marshal's) properly disinfected was exclusively used. In addition to the silk, catgut of different sizes and variously prepared was also experimented with. The ordinary catgut, duly sterilized, was generally absorbed too rapidly in renal tissue to be considered a safe material unless an extra large size was selected.

Experiments were made with the view of retarding its absorption as well as endowing it with hæmostatic properties. In the beginning the gut was allowed to remain for several days, immersed in the ordinary tincture of Ferric chloride under the impression that the time of maceration would bear a direct ratio to the necessary time required for its absorption. If, however, the maceration was continued too long the gut became soft and useless. In lieu of this, immersion just before its employment was then attempted. When this was employed the gut in a few instances was dipped in alcohol just before its use, while in others it was used just from the iron solution. Besides the tincture, Monsel's solution pure and a mixture of equal parts of Monsel's solution and water were substituted. The endeavor to obtain a hæmostatic suture material was prompted by the hæmorrhage which was at times occasioned by the introduction of a stitch which perforated a small arteriole.

Although the immersion of the gut in the iron sensibly retarded its absorption without any evil effect upon the kidney itself, yet its hæmostatic property which it thus acquired seemed rather slight.

Whenever the sutures passed clear of a vessel there was practically no hæmorrhage.

If, however, they perforated an arteriole, especially if superficial, a rather troublesome oozing arose.

The ferrated gut in a number of instances arrested this oozing, but it also failed quite a number of times. Generally, such oozing was controlled by a few stitches introduced in such a manner as to constrict the structures around the opening.

The experiments are arranged according to their nature and variety rather than their chronological order of performance. An unsuccessful attempt was made to collect the urine with the view of establishing certain practical diagnostic points in the injury of these organs, but the unmanageable nature of the subjects rendered this impossible. The importance of conservative steps in certain selected cases of these injuries cannot be too strongly emphasized.

The value of a kidney that has been subjected to an operation for an injury and again recovered has been amply tested in these experiments by the removal of its uninjured fellow. In fact, the question as to the amount of renal parenchyma necessary to sustain life has already been the subject of considerable attention.

Tuffier,¹ who has conducted a series of experimental operations upon the commoner surgical procedures upon the kidney, has arrived at the following conclusions:

Almost complete cessation of the excretion of urine and urea followed every nephrectomy, lasting however never longer than twenty-four hours. The suppression of urine is supposed to be of a reflex nature.

This author is of the opinion that approximatively 1.0 to 1.5 grammes of secreting renal parenchyma is required per kilogram of the animal, and, reasoning from this concludes that for an average person of about 70 kilograms 80 to 100 grammes of renal structure are necessary, or one-third or one-fourth of the total amount. The death of the animals which were subjected to a series of nephrectomies occurred in from twenty-four to thirty-six hours but was not attributed to a uremia, but rather to a variety of profound collapse simulating a traumatic

¹ANNALS OF SURGERY, October, 1890.

shock. The remaining part was credited according to the urine in the bladder, with continuing its function, compensation occurring partly from actual hypertrophy of the renal parenchyma and partly by the new formation of glomeruli.

While many of the questions touching upon this interesting subject may yet be impossible to decide, it seems that the resulting effect of a partial or complete nephrectomy is largely dependent upon the condition of the remaining structure. This was evidenced in Experiment 12, in which nephrectomy was practiced.

The remaining kidney, which presented unmistakable evidence of a parenchymatous degeneration, rapidly proved insufficient. While one-third or one-fourth of the secreting portion of the kidney may sustain life for a time being, yet such a diminished amount can hardly be expected to fulfill the natural demands for any length of time without breaking down from over-taxation to which it would necessarily be subjected.

The largest amount of secreting structure removed in these experiments was about one-third the total amount of a single kidney. The animal lived several months after the removal of the opposite kidney, during the whole of which it presented a broken down appearance, dependent in a measure apparently upon a toxæmia consequent to an insufficient renal action.

At times all appetite would be lost and the general appearance was that of a very drowsy condition.

At the post-mortem examination an abscess was discovered above the kidney, in connection with the supra-renal capsule together with a small abscess within the spleen.

There can hardly be a margin wide enough for the belief that death was entirely dependent upon the abscess external to the kidney.

The kidney frequently diminished considerably in size after being subjected to an operation even where this consisted of a simple exploratory incision.

The remaining secreting element of the kidney, however, usually underwent a compensatory hypertrophy.

Death is said to occur in from one to three days after the complete removal of both kidneys. In Experiment 13, this was carried out, the animal survived the removal of the second

kidney four days. During the whole of this time no outward symptoms were perceptible other than a drowsy condition.

In many of the experiments the efficacy of the recovered kidney was tested by the removal of the other organ. The only instance in which the recovered kidney seemed insufficient was in the twelfth experiment. In this the imperfect elimination of toxic refuse was very evident.

The presence of sepsis was recognized by an elevated temperature of from one to two and a half degrees, loss of appetite, diarrhoea, great thirst and a peculiar drowsy appearance.

In studying the effects of gunshot wounds a .22 ball was employed which with the kidney of a dog practically produced the same effect as that of a .32 or .38 in the human subject.

A microscopical examination of a kidney that had then subjected to a gunshot injury revealed a firm union, composed of cicatricial tissue which was surrounded by the renal structure bearing evidence of considerable contraction from the development of cicatricial tissue.

This compressed condition gradually merged into the healthy renal structure.

Where the compression was greatest the tubes were almost or even completely obliterated and the glomeruli very much contracted in size.

Parenchymatous degeneration of the cortex and a decided thickening of the capsule were distinctly evident.

INJURIES OF THE KIDNEYS.

Classification.—It seems that most authors in classifying the lesions to which the kidneys are liable, draw the line between those attended with a wound in the abdominal wall and those in which the latter is intact, considering under the first heading such injuries as contusions and lacerations, while for the latter is reserved the shot and stab injuries.

However, since the subparietal injuries are by far the most common, and when a wound in the wall does exist it is perhaps better to regard it rather as a complication, just as a renal injury may become a complication to another and more serious injury within the abdominal cavity, a simpler and possibly bet-

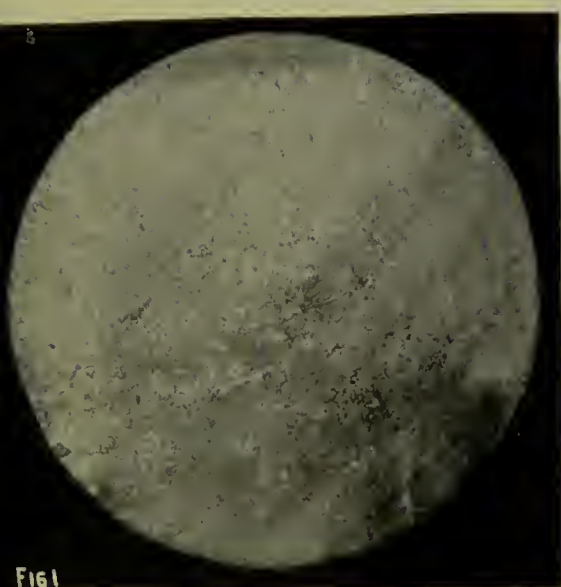


FIG. 1

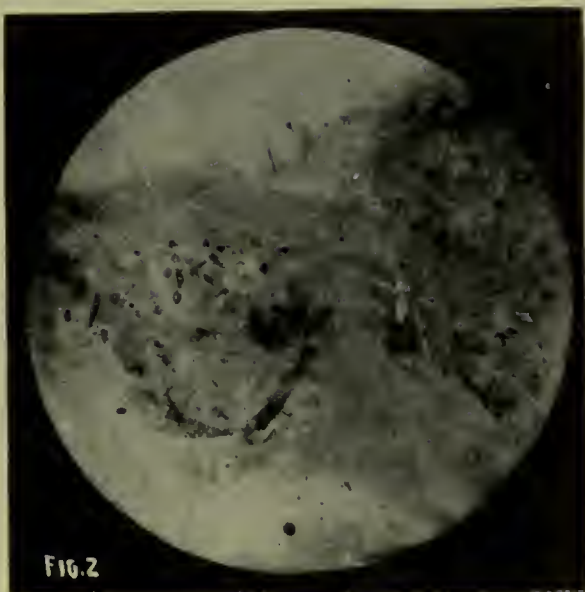


FIG. 2

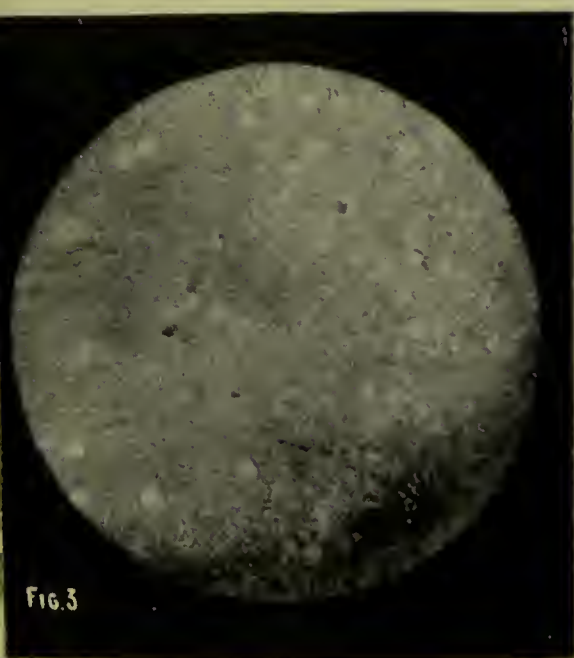


FIG. 3



FIG. 4

- FIG. 1.—Microscopic section of a wounded kidney through cicatricial tissue.
 FIG. 2.—Microscopic section of wounded kidney showing relation of true and cicatricial tissue.
 FIG. 3.—Microscopic section of normal kidney of a dog.
 FIG. 4.—Microscopic section of a kidney that had been subjected to an implantation.



ter arrangement would be into injuries of the kidney proper and injuries of its excretory duct, considering under the first heading contusions with or without rupture of the capsule and kidney structure, laceration, shot and stab injuries. Although the duct of the kidney may be injured in as many ways as the kidney itself, yet their size and more protected position makes their injury an infinitely rarer occurrence. As for the frequency with which the kidneys are injured and the abdominal wall left intact, Mr. Morris¹ remarks, that "out of two thousand six hundred and ten inspections of persons dying of all kinds of injuries and diseases there were thirteen of injured kidney, twelve of which were sub-parietal and one a penetrating wound."

Causation.—Apart from shot and stab injuries, a host of other influences contribute in determining the production of renal lesions. Among which we might repeat the well known buffer accidents, or the crushing of the trunk in a like manner between two opposing bodies, the passage of a wheel over the body in the lumbar region, direct blows upon the abdomen in the form of kicks, falling bodies, the explosion of shells, etc., falling from a height and striking against another object, the acute bending of the body and a variety of rarer accidents that occasionally likewise bring about these injuries.

Pathology.—Although the remote position of the kidneys frequently renders difficult the exact appreciation of traumatism of these organs, it nevertheless fails in protecting them entirely from any variety of injury to which a more exposed member is liable. Those who have closely searched the kidneys upon the post-mortem table it will be needless to remind of the frequency with which palpable signs of former injuries are found, and those who have sharply studied the cases which the literature affords have, no doubt, been struck with the extreme degree of the lesions upon one hand, and oftener, by the disproportion between the cause and the effect and course of the lesion upon the other. To realize and appreciate this peculiarity, it is necessary to carefully remember their anatomical structure, their physiological function, and

¹Diseases of the Kidney. Henry Morris, F.R.C.S.

the frequency with which these organs are found in a condition different from that of the healthy state. At best, its lacerable nature, its unremitting function as an emunctory and the oft congested and inflamed conditions must each lend their influence in determining the degree of the injury and shaping the character of its termination. Contusions and lacerations are the commonest varieties of injury to which these organs are liable. They may vary from the simplest lesion to an extensive laceration and destruction of the kidney. In fact, unless the contusion is singularly slight, it is generally associated with more or less rupture of the capsule or kidney structure.

The kidneys may also be lacerated to any degree. Otis mentions a case in which the kidney was lacerated through its entire long axis, death ensuing from hæmorrhage. Again, the kidney may be ruptured throughout in any direction, in which event death as a rule rapidly ensues from hæmorrhage. The rupture may be confined either to the anterior or posterior surface. In the former instance the extravasation of blood and urine occurs into the peritoneal cavity while in the latter extravasations of the same fluids are confined to the circumrenal tissues.

They may or may not be characterized with external evidences of an injury. This, however, offers no criterion as to the amount of the internal danger. Frequently, slight internal lesions are attended with extensive ecchymosis and evidences of considerable injury to the external surface, and on the other hand there may be little or no external sign to denote an extensive internal injury. Of this the two succeeding cases are fair examples:¹

“A gentleman, whilst hunting, received a bruise over the left loin and on arriving home experienced a severe pain in the back. After a very judicious treatment of several weeks the bladder finally became irritable, the urine highly offensive and mixed with pus.

The pus increased, the health becoming deteriorated and death ensued after a lapse of about two years subsequent to

¹Holmes' System of Surgery, Vol. 1, Page 8.

the accident. The left kidney was entirely destroyed, and in its structures was found a large irregular abscess with its walls adherent to the surrounding soft tissues and its cavity continuous with the ureter."

"A boy was struck over and rather in front of the right lumbar region by the handle of a truck. He immediately fell and though able to rise and walk a few steps he again fell, and was then carried to Guy's Hospital. He was in a state of extreme collapse with some pains in the abdomen. He died within an hour and a half of the accident. Externally, there was a slight ecchymosis over the extremities of the seventh and eighth ribs on the right side and the last two ribs on the left side. The cavity of the peritoneum contained a large quantity of coagulated and fluid blood. All that portion of the left kidney above the entrance of the vessels was torn from the lower portion and separated from the natural surrounding attachments. The lower portion was undisturbed. There was some ecchymosis on the surface of the liver opposite to that on the chest."

In addition to these another instance which came under the observation of the writer is mentioned further on, under the prognosis of these injuries. The wound in the abdominal wall may be of such an extent as to expose the kidney, or the exposed organ is occasionally found within the abdominal wound, or even lying completely outside of the body.

This, however, is most likely to happen where the abdominal wound is very large, and the kidney more or less movable. The hæmorrhage from renal injuries is variable, and when it occurs the clot may accommodate itself in several ways. In subcapsular lacerations, for instance, it is confined to within the limits of the kidney. Where, however, the laceration is somewhat extensive and anteriorly, the blood passes into the perirenal structures, and almost necessarily into the general peritoneal cavity. If the laceration is posteriorly the hæmatoma is found within the structures surrounding the kidney. The blood thus extravasated may become absorbed, or it may break down and suppurate, forming a nephritic or perinephritic abscess, or even give rise to a pyonephrosis. Mr. Morris, in his excellent work upon this subject, mentions a case in

which the blood remained unabsorbed—"A man who died eighteen months after the reception of a kick from a horse. Both kidneys were granular and full of cysts. The cellular tissue around the right kidney was consolidated, a large clot of blood occupying its pelvis and interior and communicated also with the exterior, where a large quantity of blood clot was lying in the subperitoneal tissue. The line of rupture could be faintly traced through the substance of the gland. The ureter was cut across about one and a half inches from the pelvis and was quite impervious."

It has also been pointed out by the same author that there may be an extensive effusion of blood into the cellular tissue around the kidney, with but little evidences of injury to the kidney itself, or, on the other hand, the kidney may "well nigh be converted to a pulp" directly from an injury, or secondarily, as the result of an injury with little or no extravasation into the surrounding structures.

Experimentally, it was observed that when the kidney was contused ecchymosis rapidly ensued, the kidney assumed a dark bluish appearance, increased in size directly in accordance with the amount of contusion, and if severe became fluctuant to the touch. This effusion may become absorbed after the same fashion as in contusions elsewhere, and no palpable sign of a former injury remain, or it may be marked by a depressed and contracted scar which represents the former injury, or, as it not infrequently happens, it may give rise to a nephritis, a nephritic abscess, a pyonephrosis, or a pyelitis.

Gunshot injuries of the kidneys are by no means rare accidents in cases of penetrating wounds of the abdomen. Otis,¹ out of 1072 cases of shot injuries within the abdominal cavity records 78 cases of shot injuries of the kidney. However, where there is a shot injury of the kidney, one or more of the other abdominal organs are almost inevitably wounded. Perhaps the intestine more than any other viscera complicates the renal injury. Hæmorrhage in these cases is usually large, and frequently determines a lethal ending.

¹Med. and Surg. Hist. of War of Rebellion, 2d Surg. Vol.

The blood alone may find its way into the circumrenal structures or into the peritoneal cavity. Where the injury involves the pelvis the extravasation is mixed with urine. The kidney may be injured through a missile in any direction, and to almost any degree, from a simple perforation to a perforation with the loss of a considerable portion of the kidney structure, or even to a shattering of the entire organ. The relative effects of the different varieties and sizes of balls has been a matter of considerable conjecture, discussion and experimentation. It can be safely stated that, as a rule, the size of the wound is in proportion to the size of the missile. However, this has many exceptions, and these exceptional effects have been attributed to a variety of influences.

The size being the same, the effect is very much moulded by its force and velocity, the character of weapon and the peculiarity of the ball. A ball traveling under diminished force is more apt to produce a lacerated puncture than one moving with great force and velocity, which generally produces a clean perforation with little or no laceration, and an almost inappreciable loss of structure.

A ball fired from a rifle created, as a rule, a greater injury than the same sized ball fired from a pistol. A difference in severity existed between a "long" and a "short" shell, the difference being in behalf of the "long." A Flobert was irregularly trimmed with a knife and thus fired. This was repeated several times, and in each instance the injury was largely in excess to that of one produced by a smooth ball. In a few the injury thus created was comparable with that of one produced by a .32 or .38 ball. The charges in shells of the same class are also frequently of very different propulsive power, which tends to control the force and velocity of the missile.

Repair under the proper conditions is frequently obtained, and where this results the track of the ball contracts and a small column of cicatricial structure completes the defect. If there is a loss of the renal structure and the same result occurs the site of injury is usually marked with a depressed scar. Finally, the kidney proper may also be injured through stabs

by means of a knife, or other pointed instruments, or as in military practice, through bayonet punctures.

Notwithstanding the size and its protected position, we have, nevertheless, a few authenticated cases of injury of the ureter. Of these we may mention the cases of Barker,¹ Stanley,² Poland,³ and the much quoted case of the Archbishop of Paris, as examples of these injuries. This duct has been injured in various ways, directly through a shot injury, as in the case of the Archbishop, or through a contusion, as in Mr. Barker's case, and several times it has been directly injured in abdominal and obstetrical operations. Mr. Newman remarks that injury to the pelvis of the kidney without penetration of the abdominal wall is as rare as rupture of the ureter. It has been observed that soon after a rupture of a ureter, a pseudo-hydronephrosis has ensued, from infiltration of the urine into the surrounding structures. Resulting from an injury, the ureter may undergo contraction, producing a stricture which subsequently causes a hydronephrosis, destroying the organ and necessitating its removal. An instance of this is recorded by Dr. Pye Smith⁴ in which a large hydronephrosis of the left kidney was produced from a kick received two years previously, and similar cases are mentioned by Mr. Croft and Dr. Harrison.

Symptomatology.—The symptoms referable to lesions of the renal organs can be divided into those relative to the constitution at large and those of a local nature. The constitutional symptoms consist of a rapid, feeble pulse, lowering of the bodily temperature, pallor, nausea, vomiting, muscular relaxation and in short the typical signs of collapse. The degree of collapse, however, in these, as in other instances, of injuries about the abdomen does not always correspond with the amount of the injury. There may be a severe injury, with little

¹A. E. Barker, Dict. Pract. Surg. Heath. Vol., I., page 864.

²Royal Med. Chir. Trans., Vol. XXVII.

³Guy's Hosp. Reports, 3d Series

⁴Newman on Diseases of the Kidney Amenable to Surgical Treatment. Page 326.

tle or no evidence of shock, or vice-versa. The emotion and other influences frequently play an important rôle in determining the degree of shock. In view of the vascularity and the liberal nerve supply, injuries of these organs are peculiarly liable to be followed by severe shock. Again, the shock is not always entirely dependent upon renal injury, *per se*, for in a large number of instances there is more or less injury to the other organs, which renders the analysis of cause and effect in many of these cases difficult. In those that are attended with a breach in the kidney structure, the amount of hæmorrhage is frequently sufficient to materially augment the constitutional symptoms. Occasionally, the condition of collapse gives way to that of a comatose state, which speedily ends in dissolution, or later, when the collapse has passed off, the symptoms of peritonitis make their appearance.

Soon after the reaction is fairly inaugurated, the local symptoms, which were hitherto largely masked by the constitutional depression, become more evident. Notable among these we have hæmaturia, pain, repeated attempts at micturition, or even anuria, muscular rigidity, fullness in the loin and the appearance of urine at the external wound.

Hæmaturia is, perhaps, the commonest and most important symptom of a renal injury. Its absence, however, is by no means a certainty of their escape, nor is its appearance an absolute sign of their involvement. Even in injuries about the lumbar regions we must not be misled by this symptom. Illustrative of this point, Mr. Newman records an excellent example.

"A boy fell from a distance of twelve feet and alighted on his side, which struck violently against the edge of a packing box. Was picked up suffering from an ecchymosis over the right eye and over the left lumbar region. The boy regained consciousness, complaining only of symptoms about the head, the hæmaturia in the meantime continuing. Minute inquiry elicited the fact that red urine had been passed previous to the injury. The boy passed on to recovery and subsequent examination proved the presence of a small papilloma in the bladder from which blood continued to flow at irregular intervals."

A variety of causes may contribute in creating the appearance of blood in the urine. In an analysis of one hundred cases, Mr. Harrison¹ found thirty dependent upon renal calculi, twenty upon enlarged prostate, thirteen upon tumors mostly malignant, fourteen upon vesical calculi, two upon traumatism and the rest divided up principally among tubercle, stricture, cystitis and a variety of other causes.

When hæmaturia occurs, it may make its appearance in from a few minutes to a few days after the reception of the injury. It may be slight, amounting to only a darkening of the urine, or, again, it may be profuse and attended with clots. The clots may assume the shape of the uriniferous tubules, the ureter or may accumulate within the bladder, causing a distention of this organ.

The absence of hæmaturia in an injury of the kidney may occur in various ways. The injury may be confined to the subcortical portion of the kidney, in which event the blood in place of finding its way into the urine is extravasated into the surrounding structures. Again, the organ may be injured to such an extent as to completely arrest its secretion. The secretion may also be arrested from the formation of a thrombus in the renal vessels. Erichsen² mentions two cases in which the absence of the hæmaturia was due to an arrest of the secretion dependent upon an extensive injury of the kidney, both cases ending fatally. Aside from these, the absence of hæmaturia may also be dependent upon a division of the ureter or the obstruction of its lumen.

The arrest of a clot within the ureter may determine a delay of this symptom and give rise to another condition resembling a renal colic.

Soon after the hæmaturia ceases, the urine may become albuminous which may last for some time and be associated with the presence of blood corpuscles, pus, mucus, renal epithelium, or casts, clearly denoting a subsequent inflammation of this organ.

Pain is another common attendant upon a renal injury. This is generally of a dull, aching character, increased with the re-

¹Reginald Harrison, *Times and Register*, Aug. 9, 1890.

²Erichsen. *Science and Art of Surgery*, vol. i, p. 822.

spiratory movements. The pain, which may be variable in degree and at its onset confined to the lumbar region, soon spreads through the lumbar and sympathetic nerves to the other parts of the abdomen, to the testicles and to the upper part of the thigh. Frequently this is marked by a retraction of the testicle. When the lumen of the ureter becomes clogged, as from a clot, the pain becomes intense and very much resembles that of a renal colic.

Fullness in the loin is frequently observed in injuries of the kidney. This fullness, for it seldom amounts to a distinct swelling, may be due to the injury of the abdominal wall alone or it may be due to the injury together with the extravasation of blood and urine, or even both into the surrounding structures. Later on, however, this fullness may be replaced by a distinct swelling, dependent upon the formation of a hydronephrosis, pyonephrosis, perinephritic abscess, or even a urinary cyst. Difficult micturition, or even complete anuria is not uncommonly met with in renal lesions, the complete absence of urine may be dependent upon the formation of thrombi within the renal vessels, upon an injury involving both kidneys, or an impaction of blood clot in the orifice of the urethra or neck of the bladder or an inhibitory nervous influence. In Mr. Poland's case¹, the almost complete absence which persisted for the last six days of the patient's life was dependent upon a thrombus in the vessel of one kidney and the laceration and extravasation of urine in the other.

Another common attendant upon renal injuries, is a spasmodic contraction or rigidity of the abdominal muscles.

Lastly we have as a symptom of renal injury the escape of urine at the external wound. This symptom, however, is not a common one and when it occurs is indicative of an injury of the pelvis or ureter. The escape of urine externally may occur soon after the injury, or it may be delayed for several days or even for a week or more; and, when this does occur it furnishes the only absolute sign of an injury of the kidney.

Diagnosis.—The remote position of the kidney, its close proximity to the neighboring organs, and its intimate sympa-

¹Guy's Hosp. Reports. 3d. Ser. Vol., 14.

thetic connections all serve to obscure the outlines and render difficult the diagnosis of a renal complication in injuries of the abdomen.

The only symptom indicative of absolute injury is the escape of urine, externally, and, since this only occurs in the fewest number of cases, penetrating wounds which form the lesser half of renal injuries and not even in all of these, we can easily appreciate the difficulty which frequently befalls the surgeon in their detection.

Apart from the above, hæmaturia is perhaps the most constant and valuable symptom occurring in these cases.

Following these we have pain, interference with micturition, rigidity of the abdominal muscles and a fulness in the flanks. If, there is a history of a direct or indirect injury to the abdomen, coupled with more or less constitutional impression and the subsequent appearance of hæmaturia, pain, muscular rigidity, difficult micturition, all of which lasting for a considerable time and marked with a tardy convalescence, sufficient grounds for the inference of a severe contusion or laceration are at hand.

Too much importance, however, must not be attached to any of these symptoms. Where the injury is of a trivial nature, the symptoms are frequently of such an indefinite character that an exact diagnosis is impossible. The diagnosis of a renal injury in penetrating wounds is not fraught with the same amount of difficulty that attends those of a sub-parietal nature. Although in shot injuries of the abdomen the damage is generally distributed over a number of the abdominal organs we are confronted with a more suggestive clinical picture as regards the renal injury.

In addition, experience has amply taught us the importance of the rule as regards the necessity of an early exploratory incision, in penetrating wounds for the thorough inspection and repair of the existing damage. The peculiar nature, the manner of their reception and the topographical relation all aid in rendering the diagnosis of stab injuries of this organ comparatively easy. It is very fortunate that an injury of the pelvis or ureter is of a rare occurrence, since the diagnosis of such a lesion is by no means of simple performance.

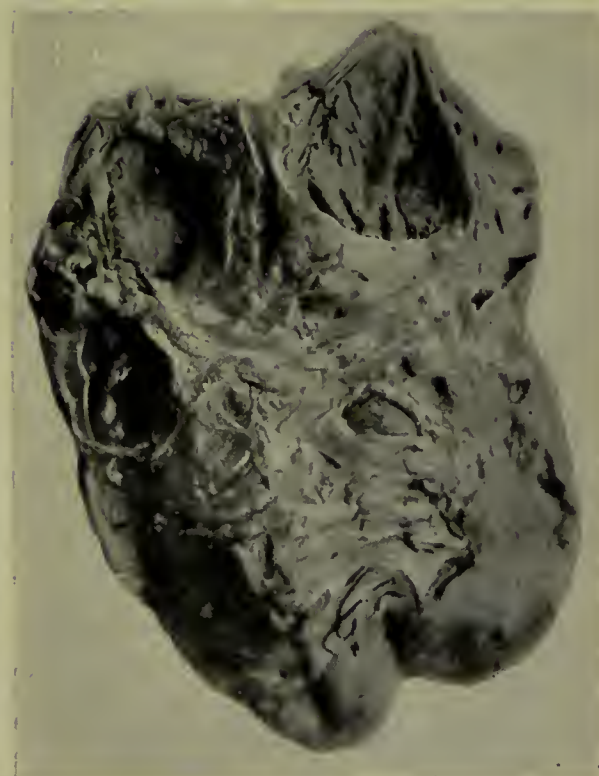


FIG. 1. (A)—Showing the result of a lateral resection of the kidney, with splenic adhesion.
(B)—Small abscess cavity in spleen

FIG. 2. (A)—Result of longitudinal resection of a portion of kidney.
(B)—Incomplete union occasioned by peri-nephritic suppuration resulting from an infection through the external wound.

FIG. 3.—Showing imperfect union from premature absorption of catgut stitches.

FIG. 4.—Interior of abscess cavity in the upper portion of a kidney and supra-renal capsule.



In the few recorded cases the principal points of note were "the absence of severe shock, the appearance of two worm-like clots and the formation of a fluctuating tumor;" or, if the injury is of the penetrating variety there may be an escape of urine externally.

Prognosis.—From the foregoing remarks under the pathology and symptomatology of these injuries it is hardly necessary to repeat, that in view of the uncertainty which surrounds these injuries, the prognosis must need be very careful. While wounds of the kidney heal very readily, and while the out-growth naturally depends upon the amount of the injury, it remains that frequently, apparently trivial injuries give rise to unfavorable consequences which not uncommonly end in a fatal termination. One of such was observed by the writer in a recent autopsy.

The case was that of an elderly man of perhaps 55 years of age, whose occupation was that of a hostler in a large stable, which work frequently exposed him to kicks from the animals. On New Year's day he was subjected to one of such accidents. Upon this occasion he received an injury of the right leg, and at the same time one in the lumbar region. From this he suffered considerable inconvenience, but was able to make his way to his home some distance off. After a rest of a few days he again attempted to resume his work. In this partly disabled condition he continued to work more or less, feeling at times comparatively easy. On the 17th of the same month he suddenly grew worse and after suffering for a few hours, expired.

At the post-mortem no external signs of violence were visible, save that of a very slight discoloration about the knee and a marked œdematous condition of the entire leg below this point. The heart was slightly dilated and in addition there were evidences of a chronic bronchitis and some marginal emphysema. General pleuritic adhesions were present upon both sides. The liver was in a cirrhotic condition. Both kidneys were movable. The upper third of the left kidney and the supra-renal capsule were filled to extreme distension with a soft, white and solid purulent matter. The bladder was incised and found containing a very small quantity of normal

looking urine. If the damage is slight, the symptoms may pass off and the patient appear seemingly recovered, while in reality the injury is gradually merging itself into a new condition.

It is to be remembered that not infrequently a nephritis, a pyelo-nephritis, a nephritic or peri-nephritic abscess result from such injuries. If the damage is severe the prognosis is always bad, the patient may either succumb to shock in a few hours, or life may be terminated later on from an excessive hæmorrhage. That the patient may recover even in the severest of these injuries there can be no doubt. Mr. Morris has recorded in proof of this a few striking examples.

There is even upon record a case¹ in which recovery followed a laceration of the kidney and the obliteration of the corresponding ureter, the patient finally dying of a granular degeneration of the opposite kidney. Should the patient, in the event of a severe injury, pass beyond the period for the occurrence of death from shock or hæmorrhage, the end may yet be determined by a peritonitis, or by the destruction of tissues from infiltration, or by the protraction of a suppurative process within or about the kidney or bladder, or lastly by the sudden rupture and discharge of an abscess into the peritoneal cavity.

Again, the prognosis may be rendered unfavorable by the involvement of the other organs within the abdominal cavity. Of these the liver is most frequently injured in connection with a renal lesion. Mr. Morris, who has written thoroughly upon this subject, refers to five dangers to be apprehended soon after the reception of the injury.

"First.—Continuous and excessive extravasation of blood leading to death by syncope within a few hours or a day or two.

"Second.—Peritonitis, either as the direct effect of the violence or the tension and ulceration of the peritoneum due to the accumulation of blood and urine which has been extravasated behind the peritoneum.

"Third.—Inflammation and suppuration of the peri-nephritic tissue, and :

¹Trans. Path. Soc. London. Vol. xi, page 140.

"Fourth.--Occlusion of the ureter by blood clot and the retention of urine within the cavity of the kidney, and its attendant effects of hydro-nephrosis, pyo-nephrosis, pyelo-nephritis, or renal abscess.

"Fifth.—Simple traumatic nephritis."

Otis¹ has recorded 78 cases of shot injuries of the kidney of which 26 recovered. Of these 26 there were 13 upon the right side, 12 upon the left and one in which this point was omitted. In an injury of the right kidney the liver is frequently implicated, whilst in that of the left we have the spleen, stomach, or ascending colon, which not uncommonly suffer in the same accident. Although the prognosis of a shot injury of the kidney alone is by no means favorable, the gravity is naturally increased by the complication of an injury to one or more of the other abdominal organs. An injury of the urinary duct is justly regarded as a serious accident, necessitating in the majority of instances a removal of the organ.

Where the injury is not accompanied with too much laceration recovery may occur for a time, only to be succeeded by a stricture of this duct with an accompanying hydro-nephrosis and destruction of the organ.

Treatment.—The treatment of these injuries naturally varies with the character of the lesion. The most pertinent question which addresses itself to the judgment of the surgeon is the determination of the opportune moment when active interference is demanded. In some, the boldest measures are indicated from the very onset of the injury, while in others complete recovery occurs from a conservative or purely medical line of treatment. The fulfillment of this can only be hoped from a careful knowledge of the symptoms and a very close study of the progress of the case. Even with all this, the course, and symptoms are frequently so vague that in spite of the most careful attention, the ripest opportunity is frequently lost and the organ which was within our efforts is not only lost, but the case often terminates in the death of the individual.

For the sake of clinical reference the treatment is best divided into that of the contusions and lacerations, that of the

¹Medical and Surgical History of the War of the Rebellion. Second surgical volume.

shot and stab injuries, that of the injuries of the duct, and lastly the treatment of the conditions consecutive to the injury. Contusions and lacerations.

In this variety the imperative indication is the enjoinder of absolute rest in bed. To still further fulfill this demand and for the relief of the pain, the administration of opium should be employed. The bowels should be somewhat constipated and if moved, this should be accomplished by means of a bland enema. In order to loosen the solid residue which tends to increase the vermicular motion and favor the dislodgment of a clot, the food should partake of the nature of a light and a liquid character. All stimulants and substances that are likely to increase the action of the kidneys should be carefully avoided. For the arrest of the hæmorrhage, various remedies have been urged, prominent among which might be mentioned such drugs as ergot, iron, gallic acid, alum, acetate of lead and opium.

But at best, it seems that very little can be expected from these, for if the hæmorrhage is severe enough to be of sufficient note, such drugs can hardly be hoped to supply the want. On the contrary, if it is slight, the hæmorrhage can be expected to be arrested by an absolute quiet, secured through the opium or the use of a full dose of ergot internally, or ergotine sub-cutaneously may also contribute to this end. If any decided benefit is to be derived from any of these it can best be expected from the opium and ergot.

In addition to these, venesection has been recommended in certain strong and healthy individuals with the hope of lessening the blood pressure and diminishing the danger of a rupture into the peritoneal cavity. Locally, the strapping of the affected side and the application of ice externally are to be remembered as adjuvants in securing an immobility of the injured side and in assisting the control of the hæmorrhage. In those cases that are marked with a transient collapse, slight hæmaturia, a limited degree of pain, with a slight area of dullness and with practically little or no fulness, the surgeon can be content with such steps as the careful regulation of the diet, the immobilization of the injured side through the application of adhesive strips applied from the spine to the linea

alba, the observance of perfect quiet in bed assisted by the administration of opiates and the checking of the hæmaturia by means of the application of ice externally, and the use of ergot and morphine internally.

An attempt can be made through this line of treatment to create a favorable termination, the surgeon in the meantime holding himself in readiness to assume a more active rôle upon the appearance of any untoward symptom. Should, however, the case be one marked with a notable degree of collapse, persistent or an exaggerated hæmaturia with a distinct fullness in the loin and a considerable area of dulness, it becomes the surgeon's imperative duty to, as promptly as is consistent, explore the injured region. Should the laceration not be too extensive, as for instance a complete division of the organ, an attempt should be made for its preservation. With this end in view, the surrounding region should carefully be freed of all blood clots and cleansed by a thorough irrigation with a sublimate or Thiersch's solution. As for the rent in the kidney, this should be carefully and thoroughly tamponed, together with the surrounding space and, if needbe, the external wound with sublimated or iodoformized gauze.

This can be allowed to remain until all danger of hæmorrhage is past, or until indications arise requiring an earlier removal, the tampon being renewed as often as the urgency of the case may demand. Should the kidney be completely severed, or severely lacerated with several deep fissures, or in a softened and broken down state, nephrectomy is the only alternative. But as already mentioned, it is a very delicate question for decision, to recognize those cases which demand immediate interference, those which require no interference, and those in which operative measures are required secondarily for the relief of the condition, or the correction of a process consecutive to the injury. The exploratory incision, not only affords an accurate means of diagnosis, but allows a more rational plan of treatment, besides affording an easy exit for any extravasated urine and the removal of any clots.

Gunshot injuries of the kidneys are justly to be regarded as serious accidents. This is dependent upon the profuse hæmorrhage which attends these cases and upon the frequency with

which they are accompanied by lesions of other abdominal organs.

The means of controlling the hæmorrhage which has always been an important question in the treatment of these cases, has been enlarged upon in these experiments.

For the purpose of management these injuries have been divided into four classes :

First.—Those in which the injury amounts to a superficial laceration, the missile grazing the kidney and carrying with it a portion of its structure, with a remaining surface not unlike in appearance to that of a granulating wound. In these the hæmorrhage is dependent upon the number of vessels exposed and is not infrequently of a considerable amount. A second variety, which amounts to simply a perforation, with little or no appreciable loss of structure. Here the passage usually contracts until it is smaller than the ball itself. This variety is, by far, the safest in character and the most amenable to treatment. A third variety in which the puncture is attended with a loss of kidney structure. In these the wound of entrance is of the size of the ball, whilst that of exit is quite large and attended with the destruction of a portion of the kidney.

Lastly, a fourth class in which the kidney is lacerated beyond redemption or in which the renal artery or a large branch of the same either within or external to the kidney is ruptured.



FIG. 1. "Purse-string" suture applied to a gun-shot perforation.

In this class, the extirpation of the organ usually becomes the only alternative. Again, the missile may hopelessly injure either the pelvis or ureter. If the injury of the pelvis is created by a small sized ball, an attempt may still be made to preserve

the organ, but where the pelvis is considerably lacerated, or the ureter severely wounded, nephrectomy is the most effectual means of dealing with these cases. Although, even a large branch of the renal artery be divided an effort may still be made to save the organ. The first step in the treatment of any of these, is the establishment of the positive existence of an injury and for this end the recognized rule is to be remembered, that apart from the most exceptional instances exploratory laparotomy should be performed.

The aseptic nature of gunshot wounds in external regions, has long since been pointed out by Bergmann, Esmarch and others, and, acting under the impression that the same would be true as regards such wounds within cavities, experiments were made with the intention of demonstrating this and the establishment of operative measures for their treatment based upon this principle. At first such wounds as are depicted in the second class were treated by transverse sutures over the orifice of the wound, in various directions. Although the results were entirely satisfactory as regards the recovery, this was finally replaced by a "purse-string suture," which has for



FIG. 2. Gun-shot perforation sealed by a "purse-string" suture.

it the advantages of being easier and more readily applied, in being less liable to tear, and, lastly, in its remote relations to the raw edges of the wound which are thus drawn together in their original condition.

In applying this suture, as well as in all operative procedures upon the kidneys, care should be observed to preserve the capsule and circum-renal structures which contribute so largely to the strength of the purchase. Where, in a deficiency, or an absence of these, strength is desirable, the stitches can

be introduced deeper into the medullary portion, which through its extra quantity of connective tissue, affords a stronger grasp for the stitches.

The orifice thus closed, is securely sealed against hæmorrhage, organization soon follows, which leads to an early and



FIG. 3. Introduction of a twisted, double suture for the control of hæmorrhage by means of a double "purse-string" contraction.

definitive healing. In those injuries of the first class, the hæmorrhage is usually severe. Resection was practiced in some of the experiments for the control of this. The "purse-string suture" applied about 1 centimeter from the edge was successfully tried in smaller wounds and finally likewise adopted in wounds of a larger size. Thus treated, the hæmorrhage



FIG. 4. Showing the application of a double "purse-string" suture for the arrest of hæmorrhage in large superficial gun-shot wounds.

promptly ceased, the uneven granular surface was absorbed, leaving behind a smooth, depressed scar of the former lesion. Where the wounded area is unusually large the compression

obtained through a single suture is occasionally insufficient. In such instances, the surface is divided into halves and each half separately constricted by means of a suture proper to itself. Should a rebellious vessel still escape compression, this can be secured by a separate stitch introduced for this purpose after the manner of transfixion. This measure can be supplemented with the sear of a Paquelin cautery. The value of this, however, can hardly extend beyond the arrest of an oozing, which is, as a rule, easily controlled by means of the suture.

In those injuries that are characterized with a small wound of entrance, while that of exit is large and marked by a loss of



FIG. 5. Introduction of stitches for the closure of the deeper portion of a resection.

structure, there are two procedures open, the choice of which being largely dependent upon the location of the injury. When the wound is near, or upon the external border, a resection of the entire injury is perhaps the safest and most feasible measure. Should the wound, upon the other hand, be located near the center of the organ the application of a "purse-string suture" to both openings, or the smaller opening may be sutured while the larger is tamponed with sublimate or iodoform gauze and drained through a lumbar incision. Where resection becomes necessary the triangle which is removed should include only the necessary structure and if possible should reach short of the pelvis of the organ. The observance of this practically excludes the dangers of fistulæ and the extravasation of urine. In bringing together the divided surfaces, the entire wound from top to bottom should be united by means of deep interrupted stitches of chromicized cat-gut or silk introduced about 2 or 3 centimeters from the edge, while the superficial edges are

opposed by another row of sutures. This can be still further secured by suturing over the divided edge the capsule and circum-renal structure.

Although if the pelvis is laid bare, it should be thoroughly irrigated and freed of all clots before closure of the wound is undertaken. For the control of the most troublesome obstacle in operations upon the kidney the author has devised a clamp for the compression of the renal artery, with the hope of securing a bloodless, or almost bloodless operation. In stab injuries of this organ, the external wound, if necessary, should be enlarged and the exact character of the renal injury determined. If the



FIG. 6. The method of closing resections and deep exploratory incisions.

wound is such that it will admit of an easy apposition, and from the nature of its production the surgeon feels safe as to its aseptic nature, it should be closed just as though it was a simple incision for the purpose of exploration. Or, the closure can be preceded by an irrigation of the wound with a sublimate solution, 1 x 2500.

If it is evident that for some reason these measures cannot be fulfilled, the surgeon has left, as a last resort, the tamponade and drainage through the loin. Penetrating wounds involving the pelvis should be closed by means of a single or double row of sutures. For injuries of the ureter, unless singularly slight, nephrectomy seems the only alternative, for even though union should result, the dangers of a stricture with the subsequent risk of a hydronephrosis and destruction of the kidney are not to be lost sight of.¹ Injuries of the kidney are frequently attended with secondary complications which require separate interference for

¹ Nussbaum has successfully resected a portion of this duct for a wound of the same during an ovariectomy. *Surgery of the Kidneys*—J. Knowsley Thornton.

their correction. Among these, a very common accident is the accumulation of blood-clots within the bladder.

Generally, when hemorrhage occurs into the bladder it is promptly evacuated, but occasionally the blood coagulates and not infrequently gives rise to a considerable annoyance. Should the coagulation amount to a few small clots they seldom give rise to any trouble, as the urine exerts a solvent influence there-upon and favors their removal.

Should this be insufficient, the bladder should be thoroughly washed with a mild solution of boric acid, and, if necessary, an evacuating apparatus (Bigelow's) employed for the removal of the clots. Where these measures fail, cystotomy should be performed without further delay. Another common attendant upon these injuries is the extravasation of blood, or urine, or both into the surrounding structures. Although the occurrence of the former is not necessarily dependent upon an injury of this organ, for hæmatomas of considerable size have resulted from the rupture of muscles in this region, or from anastomoses between external and internal arteries, or lastly, from an aneurism of some intra-abdominal artery. Moreover, it is not always an easy matter to discriminate between the extravasation of blood and urine and where there is a perceptible fullness or swelling between either of these, and the swelling caused by an enlargement of the kidney itself. For the discrimination of these, Rayer has suggested the point, that extra-renal extravasation is, as a rule, not as distinct in its outline as in a fullness dependent upon intra-renal extravasation. This, however, is an exceedingly fine discrimination, and in real practice is often quite difficult to execute. The effusion may occur rapidly, as from the rupture of a large vessel, and with the usual signs of a severe hemorrhage.

Frequently it assumes an enormous size, dissecting away the peritoneum, permeating the surrounding structures, and occasionally finding its way along the Psoas and Iliacus muscles into the groin.

Where the diffused hæmatoma is of a rather slow origin, its detection and differentiation is fraught with some difficulty. It may remain unabsorbed, or it may pass through a process of absorption and disappear, or, finally, it may break down and become converted into a nephritic or perinephritic abscess. The

course of these extravasations should be carefully guarded, lest they break down and suppurate, bursting finally into the general peritoneal cavity, or dissecting up the neighboring muscles, or burrowing along the Psoas muscle finally to open spontaneously in the groin, or thigh. Probatory punctures with a strictly aseptic aspirating needle should be repeatedly made in different directions. At the appearance of the slightest evidence of pus, early incision through the loin and drainage should be resorted to.

Closely allied to the foregoing is the extravasation of urine. The manner of its distribution, the nature of its production and the obscurity of the symptoms not infrequently make it a difficult matter at times to discriminate between these two conditions. Like the former, its origin may be either of a rapid formation or its growth may be extended over several weeks ere sufficient signs or fullness are present to excite suspicions of an extravasation.

The extravasation may become partly or entirely absorbed, it may excite inflammation and suppuration of the surrounding structures leading to an abscess, which may follow the same course as mentioned in the preceding complication, or it may become incapsulated within a boundary of inflammatory formation producing a pseudo-hydronephrosis.

The infiltrated urine may become mixed with pus, or, as in Mr. Barker's case, concretions of a phosphatic nature may be formed within the sac. The behavior of tissues when infiltrated with urine has been, to say the least, a most interesting subject. In some, the normal urine has excited an intense inflammatory action, ending in suppuration and destruction of the tissues, while on the contrary there is ample evidence of the harmless nature of this fluid, at least under certain circumstances. The experiments of Simon¹ in this direction have conclusively indicated this.

In short, the experiments have demonstrated that normal acid urine is readily absorbed when injected into the tissues in from a dram to a pound quantities; that urine, more or less ammoniacal or containing pus, is capable of producing a progressive inflam-

¹ *Ueber die Einwirkung des Urins und Speichels auf die nachte d. i. nicht mit Epithel bekleideten Gewebe v.* Prof. G. Simon, Heidelberg. *Deutsche Klinik*. April, 1869. Nr. 15.

mation of the tissues and a gangrenous condition of the skin. He has further added clinically to the strength of those experiments by using for the sponging of wounds in certain plastic operations, urine in place of water, obtaining, notwithstanding this, primary union in every instance. This author is inclined to the belief that the evil effects of the normal acid urine are not due to its direct action, but rather to an interference with the nutrition of the structures which it causes by separating the muscles with its presence in the intermuscular spaces and by elevation of the skin from its underlying bed, thus seriously compromising the nutrition.

Furthermore, we have the experience of Thornton,¹ which speaks in a similar tone. During a difficult ovariectomy this operator cut the left ureter, which accident was only discovered the following day. Meanwhile the urine continued to flow into the peritoneal cavity, finally making its exit through the drainage tube, saturating the dressings. Although this had been going on for twenty-four hours the peritoneum was not even red. The case recovered soon after a nephrectomy.

When the presence of extravasation is established, it should be promptly relieved for the protection of the surrounding structures. For the fulfilment of this measure, we have the choice of three procedures :

First.—The simple aspiration, repeated if necessary, has in a number of instances been attended with success. Where the sac continues to refill, incision and drainage is indicated. Should the condition continue, dependent upon a stubborn fistula from the pelvis or a severe wound of the kidney, or the ureter, nephrectomy is in most instances the proper step for its relief.

Another complication of note is the appearance of peritonitis. This may occur primarily from the injury itself, or, it may follow secondarily upon some operative measure. The fact of its occurrence, however, can only be regarded as a logical proof of the presence of some condition which requires an active interference. In nearly all of the penetrating and many of the non-penetrating wounds exploratory incision is indicated and carried into effect. In the excepted cases, unless the condi-

¹J. K. Thornton, *Internat. Med. Cong. Rep.*, 1884. Vol. II.

tion is incompatible with such a step, the appearance of peritoneal symptoms should demand an early exploration.

Where the peritonitis follows secondarily to an abdominal section, made for the repair of such an injury, the use of salines should be employed. For the fulfillment of this end a variety of salines are at hand, none, perhaps, acting with as much certainty and satisfaction as the magnesium powder (oxide) administered in a carbonated beverage.

Should the use of these fail in favorably influencing the peritoneal reaction, an exploration is in order, unless an attending circumstance contra-indicates this step. Apart from these, occasionally there occurs a nephritic or perinephritic abscess, a traumatic nephritis, a pyonephrosis or hydronephrosis, or a host of other sequelæ and complications which more properly deserve an undivided consideration.

EXPERIMENTAL OBSERVATIONS UPON INJURIES OF THE KIDNEY.

EXPERIMENT 1. Aug. 28. Small size dog. Weight 5.5 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol. The ball penetrated the kidney transversely, midway between the external and internal border, near the center of the viscus. The wound of entrance was small and closed by sealing over the orifice with silk. This procedure effectually arrested the hemorrhage from this opening. The wound of exit, however was large and could not be subjected to this treatment. In lieu of this, triangular excision of a portion including the lacerated defect, was resorted to.

The cut surfaces, which bled freely, were each covered with strips of omentum, and the walls brought together by deep and superficial interrupted sutures.

This approximation required a few additional sutures at the inner angle before the hemorrhage ceased.

Given 4 Cc. Magendie's Sol. and removed.

Aug. 29. Walks with unsteady gait and refuses food.

Aug. 30. P. M. Very weak. Died this afternoon. Wound of entrance closed and of an apparently promising appearance. The resection and some distance beyond in a softened and broken down condition. Death from the effects of traumatism.

EXPERIMENT 2. Aug. 28. Small size dog. Weight 7 kilograms. Kidney exposed and shot with a Flobert from a S. & W. pistol. The

ball grazed the external border of kidney, creating a wound of about 1 Cm. deep and about 4 Cms. in circumference.

The lesion was treated by excising a triangular portion of the organ which included the entire wounded surface. The fresh surfaces were brought together by deep and superficial sutures which completely arrested the hemorrhage.

Given 4 Cc. Magendie's Sol. hypodermically.

Aug. 29. Very feeble, refuses food.

Aug. 30. Walks about, takes food and suffers great thirst.

Sept. 8. Apparently recovered. The animal was now subjected to a removal of the uninjured kidney.

Sept. 9. Refuses food, but seems otherwise very little affected by second operation.

Sept. 10. Takes food freely and appears lively.

Sept. 11. Same.

Oct. 18. The animal appears in perfect spirits. Has apparently gained in weight and shows no signs of the former operations. Sacrificed for the examination of the remaining kidney.

P. M. Kidney diminished in size. The site of resection marked by a slight omental adhesion and the edges rounded and partly gaping. Union of the surfaces being only partial and no fistula.

EXPERIMENT 3. Sept. 19. Large size dog. Weight 21 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol, the ball passing transversely through the center of the organ.

The orifices, which were small, were closed by a row of sutures.

In closing the wound upon the external surface, the circumrenal fat was utilized and drawn over the wound more securely closing the orifice. This effectually arrested the hemorrhage.

Given 4 Cc. Magendie's Sol. and removed.

Sept. 20. Refuses both food and water, but walks about and otherwise appears unaffected.

Sept. 21. Takes food and appears lively.

Sept. 22. Same.

Oct. 28. Killed to obtain the specimen.

P. M. Kidney in a firm condition, marked only by two small depressed scars.

EXPERIMENT 4. Sept. 22. Small size dog. Weight, 10 kilograms. Kidney exposed, and shot with a .22 ball from a S. & W. pistol. The ball passed directly through the long axis of the organ. Both openings were closed by silk sutures, which arrested the hemorrhage. Given 4 Cc. of Magendie's Sol. and removed.

Sept. 23. Drinks water freely and took a small portion of raw meat.

Sept. 24. Died towards evening.

P. M. Cavity contained about 200 Cc. of bloody fluid of a somewhat purulent character. Feeble adhesions between the intestines and omentum. External appearance of the wound unchanged. Upon section the track was found filled with a perfectly clean clot. Death from acute sepsis.

EXPERIMENT 5. Sept. 22. Small size dog. Weight, 6.5 kilograms. Kidney exposed and shot with a Flobert from a S. & W. pistol. The surface of the ball had been cut with a knife, giving it an uneven appearance. The ball passed directly through the long axis of the organ, creating at its entrance a small opening marked by several diverging fissures.

The wound of exit was very much lacerated and attended with a loss of kidney structure. The wound of entrance was closed with silk sutures, and that of exit was carefully trimmed, removing the prominent lacerated edges. The hemorrhage from this opening was partly arrested by means of interrupted stitches applied in different directions and partly by the implantation of the omentum. Given 4 Cc. Magendie's Sol. and removed.

Sept. 23. Refuses food and appears feeble.

Sept. 24. Takes a small quantity of food.

Sept. 25. Improving.

Sept. 26. Appears lively and eats with good appetite.

Oct. 5. Nephrectomy was practiced upon the uninjured kidney.

Oct. 6. Took a few ounces of milk.

Oct. 7. Appears hearty.

Nov. 23. Killed to obtain specimen.

P. M. Kidney firmly united and omental implantation strongly adherent.

EXPERIMENT 6. Sept. 29. Large size dog. Weight, 17 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol. The ball passed transversely through the kidney near the centre. The wound of entrance was small and closed with a continuous silk suture. The wound of exit was at least four times larger than the wound of entrance.

The closure of this was unsuccessfully attempted with interrupted silk sutures. The hemorrhage was finally arrested from this source by means of a purse suture. The contused tissue, which slightly

projected, was carefully trimmed away and the organ returned. The cavity was thoroughly cleansed and closed.

Given 4 Cc. of Magendie's Sol. and removed.

Sept. 30. Walks about. Drinks large quantities of water, but takes sparingly of finely-chopped meat.

Sept. 31. Appears hearty. Eats and drinks freely.

Nov. 3. Perfectly recovered. Nephrectomy was practiced upon the uninjured kidney.

Nov. 4. Refuses food and water.

Nov. 5. Takes both food and water.

Dec. 8. Lively. Eats and drinks heartily. Killed to obtain the injured kidney.

P. M. Small cicatrix marking the wound of entrance. Upon the opposite side there was an appreciable depression with a few adhesions.

EXPERIMENT 7. Oct. 19. Medium size dog. Weight 15.5 kilograms. Kidney exposed and shot with .22 ball from a S. & W. pistol. The missile shattered the lateral aspect and then passed through the kidney beneath a bridge of renal tissue. The whole track was resected, leaving a little over two-thirds of the kidney behind. Almost perfect apposition was obtained by a series of deep and superficial stitches. The kidney was thoroughly irrigated and returned. The cavity was washed and carefully sponged to free it from clots. The shock that followed this operation was quite marked and dependent largely upon the excessive hemorrhage. Given 4 Cc. of Magendie's Solution, hypodermically, and a rectal injection consisting of 300 Cc. of a warm solution of chloride of sodium, with 60 Cc. of dilute alcohol. The deep stitches in this experiment consisted of catgut that had been immersed in the tincture of chloride of iron and then dipped in the U. S. P. alcohol. Rallied from shock in about two hours.

Oct. 20. Refuses food and lays quiet.

Oct. 21. Remains in one place. Took a few ounces of milk and water.

Oct. 22. Took a small quantity of raw meat and water.

Oct. 23. Same.

Nov. 2. Has been progressing nicely. Presents a somewhat emaciated appearance, but eats well and appears lively.

Nov. 10. Nephrectomy was practiced upon the remaining kidney.

Nov. 11. Refuses food and water.

Nov. 12. Improved.

Nov. 13. Eats and drinks.

Nov. 16. Refuses food.

Nov. 17. Eats heartily again. Continued thus, being fed entirely upon a diet of raw beef, till Dec. 26.

Dec. 27. Refuses to eat and drink. Very emaciated and suffering from a diarrhœa.

Dec. 28. Refuses food. Diarrhœa increased. Stools streaked with blood. Animal quite weak.

Dec. 29. Condition exaggerated.

Dec. 30. Found dead. The animal in a very much emaciated condition. The bony prominences presented a raw and somewhat ulcerated appearance. These raw surfaces at times would heal, but only to break open and recur.

P. M. The animal had already been dead eighteen hours. The intestines only slightly congested here and there. The spleen small and quite hard. The kidney diminished in size, marked upon its external surface by two shallow fissures; upon its internal surface by an omental adhesion and a depressed cicatrix marked by several diverging cicatricial lines. At the upper extremity of the kidney there was adherent a globular body of about 5 Cm. in circumference, which from all appearance, seemed to be the supra-renal capsules, filled with a soft but thick, purulent matter. The kidney was firmly united and in a good condition. The superficial suture, which was a continuous one, still imbedded. The deep sutures were absent. The remainder of this kidney represented about five-eighths of its secreting surface. The spleen upon section revealed a small abscess cavity. Unfortunately, other organs not examined. Death very likely from the suppurative process, favored, in all probability, by a renal insufficiency.

EXPERIMENT 8. Oct. 19. Medium size dog. Weight 18 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol.

The ball took a superficial course, passing along the upper surface, tearing away a portion of the kidney, which left a lacerated bleeding surface. Resection was practiced, removing not quite as much of the kidney structure as in the foregoing experiment. The deeper parts were apposed by ferrated catgut and the superficial edges by means of silk. The organ was thoroughly irrigated and returned.

Given 4 Cc. of Magendie's Sol. and removed.

Oct. 20. Refuses milk and water and remains quietly in one place.

Oct. 21. Takes a small quantity of food and lies very quietly.

Oct. 22. Same.

Oct. 23. Great thirst. Refuses food.

Oct. 24. Found dead.

P. M. Cavity contained 700 Cc. sanguino-purulent fluid, no adhesions. Kidney softened and broken down. Death from extravasation of urine and septic matter into the peritoneal cavity.

EXPERIMENT 9. Oct. 10. Medium size dog. Weight 14.5 kilograms. Kidney exposed and shot with a .22 ball obliquely through its long axis. The wound of entrance was small and closed with a double row of silk. The wound of exit was large and in a lacerated condition. Closure of this was accomplished partly by the purse suture and partly by omental implantation.

Kidney sutured and given 4 Cc. of Magendie's Sol.

Oct. 11. Refuses food, but otherwise appears strong.

Oct. 12. Takes food and appears lively.

Oct. 13. Same.

Nov. 16. The dog appears lively, eats well and apparently perfectly recovered.

Nephrectomy was practiced upon the uninjured kidney. In the removal of the kidney the ligature slipped and a profuse hemorrhage ensued. It was only secured after enlarging the wound. Cavity was carefully cleansed and closed.

Given 4 Cc. Magendie's Sol. and removed.

Nov. 17. Walking about. Refuses food, but very thirsty.

Nov. 18. Same.

Nov. 19. Found dead.

P. M. Cavity contained 70 Cc. of sanguino-purulent fluid and a few feeble adhesions. The opposite kidney was found perfectly healed with implanted omentum adherent, together with a coil of intestine. Death from acute septic peritonitis.

EXPERIMENT 10. Nov. 1. Medium size dog. Weight 17 kilograms. Kidney exposed and shot with a .22 ball through its long axis.

The wound of entrance was closed with a double row of silk sutures.

The wound of exit was partly sealed with a double row of sutures, assisted by an implantation of omentum.

Given 4 Cc. of Magendie's Sol. and removed.

Nov. 2. Refuses food and water.

Nov. 3. Takes a few pieces of raw meat and water.

Nov. 5. Refuses food.

Nov. 6. Anæsthetized and lumbar wound, which was gaping and of a necrotic appearance, carefully washed out, trimmed and enlarged. The kidney drawn into view and found very slightly gaping, with the

omentum adherent. The omentum carefully removed for inspection and closure of the deeper parts. The kidney was thoroughly irrigated and returned. Stimulated with hypodermics of whisky.

Nov. 7. Found dead.

P. M. Cavity clean. A few feeble adhesions. Death from septic peritonitis.

EXPERIMENT 11. Dec. 28. Large size dog. Weight 26.5 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol, creating a superficial laceration upon the surface of the organ. The bleeding surface was thoroughly irrigated and a purse suture applied. This effectually arrested all hemorrhage.

Given 4 Cc. of Magendie's Solution and removed.

Dec. 29. Up ; appears lively and takes a quantity of raw meat.

Dec. 30. Same.

Jan. 20. Killed to examine specimen.

External wound almost entirely healed. The injured surface presented a depressed appearance with no diminution in the size of the kidney.

EXPERIMENT 12. Dec. 12. Large size dog. Weight 23 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol, the ball passing obliquely through the organ. Various sutures applied in different directions, but failed to arrest the hemorrhage. The kidney was in such a state of degeneration that no purchase could be obtained by any suture. Nephrectomy seemed the only alternative and was performed.

Dec. 13. Walks unsteadily and refuses food.

Dec. 14. Same.

Dec. 15. Takes a small quantity of milk.

Dec. 16. Presents a drowsy appearance. Slight diarrhœa.

Dec. 18. Diarrhœa increased. Indifferent to food. Expression stupid and very much emaciated in appearance.

Dec. 20. Condition about the same. Diarrhœa increased and streaked with blood.

Jan. 5. Found dead. From the last to the present date, the animal gradually lost ground. The appetite became more affected, the form more emaciated and the diarrhœa increased. The expression throughout was one of utter apathy.

P. M. Cavity clean. The remaining kidney enlarged, hyperæmic, granular and degenerated. The small intestines of an anæmic appearance, marked by hyperæmic patches. Death from nephritis

EXPERIMENT 13. Dec. 31. Large size dog. Weight 19 kilograms.

Kidney exposed and shot with a .22 ball from a S. & W. pistol. The ball passed obliquely from the external to the internal border, severing a large branch of the renal artery and completely shattering the pelvis of the kidney.

The wound of entrance was sealed with a purse suture. Resection was unsuccessfully attempted for the wound of exit. Nephrectomy was indicated and performed.

Jan. 1. Up, and walking about. Takes a small quantity of meat.

Jan. 18. Recovered from the nephrectomy. Eats and drinks heartily. External wound almost healed. Nephrectomy was again performed upon the remaining kidney at 8 P. M.

Jan. 19. Refuses food and water. Remains quietly in the same place.

Jan. 20. No change.

Jan. 21. Same.

Jan. 22. Died sometime between 7 and 9 P. M.

P. M. Cavity clean. The intestinal mucous surface apparently normal.

Before death the animal appeared dull and indifferent.

EXPERIMENT 14. Nov. 13. Small size dog. Weight 6.5 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol. The ball passed through the long axis of the organ. The wound of entrance closed with a silk suture. That of exit closed in a similar manner and reinforced by a covering of omentum.

Given 4 Cc. of Magendie's Sol. and removed.

Nov. 14. Refuses food. Takes a small amount of water.

Nov. 15. Eats and drinks.

Nov. 16. Same.

Dec. 21. Recovered and subjected to another experimental operation.

EXPERIMENT 15. Jan. 10. Medium size dog. Weight 8 kilograms. Kidney exposed and compressed in two contiguous spots with blunt forceps. The instrument left a deep, blanched spot, which soon swelled up and became cyanosed for some distance beyond. Kidney returned.

Given 4 Cc. of Magendie's Sol. and removed.

Jan. 11. Up and takes food.

Jan. 12. Seems very little affected by the injury.

Jan. 21. Apparently recovered. Eats and drinks heartily. Killed to examine the specimen.

P. M. Kidney depressed in the spots corresponded to the injury. Evidences of cicatricial tissue around the seat of the former lesion.

EXPERIMENT 16. Jan. 10. Medium size dog. Weight 8.5 kilograms. Kidney exposed and lacerated by bending it up on itself. This produced a lacerated wound marked by a considerable degree of contusion. The laceration, which was double, measured about 3 Cm. in length, and about 1 Cm. in depth. Hemorrhage resulted to a notable degree. The surface was thoroughly irrigated and the edges of the laceration brought together by deep sutures of silk. Kidney was carefully returned.

Given 4 Cc. of Magendie's Sol. and removed.

Jan. 11. Refuses food. Walks about.

Jan. 12. Same.

Jan. 13. Eats a few pieces of raw meat.

Jan. 14. Eats sparingly. Appears apathetic.

Jan. 15. Refuses food.

Jan. 16. Refuses food.

Jan. 18. Eats and drinks.

Jan. 19. Same.

Jan. 22. Found dead.

P. M. Omentum and spleen adherent. The laceration gaping and covered with a yellowish suppurating surface.

Sutures still imbedded. A small abscess was found communicating with the laceration.

Death from exposure.

EXPERIMENT 17. Jan. 10. Medium size dog. Weight 9 kilograms. Kidney exposed and compressed with the same instrument that was used in the previous experiment, but with almost double the amount of pressure. The kidney enlarged and rapidly assumed a bluish color for some distance beyond the lesions.

Given 4 Cc. of Magendie's Sol. and removed.

Jan. 11. Takes a few pieces of raw meat.

Jan. 12. Same.

Jan. 13. Very much improved—appetite better.

Jan. 22. Appears recovered. Eats and drinks heartily and is apparently recovered.

Disappeared.

EXPERIMENT 18. Small size dog. Weight 6.5 kilograms. Kidney exposed and the clamp applied to the renal artery. An oval piece measuring 7 Cm. in circumference and 1 Cm. in depth was carefully sliced off. The raw surface was surrounded by a purse-suture intro-

duced about 1 Cm. from its edge. The clamp was released and hemorrhage in one or two spots at the lower half of the raw surface returned. An unsuccessful attempt was made to arrest the hemorrhage from these points by the sear of a Paquelin cautery. This arrested the hemorrhage in all but one small artery. The hemorrhage from this was finally arrested by a second suture introduced through the middle of the wounded surface, and brought around its lower border in such a manner as to include the lower half of the wound. Cavity was sponged.

Given 4 Cc. Magendie's Sol. and removed.

Jan. 11. Refuses food. Takes a few ounces of water.

Jan. 12. Eats and drinks.

Jan. 13. Same.

Jan. 27. Lively. Eats and drinks heartily.

Killed for further examination.

P. M. The wounded kidney was covered with adherent omentum and spleen in a very firm manner.

EXPERIMENT 19. Jan. 16. Small size dog. Weight 7 kilograms. Kidney exposed and severely compressed in three places. The organ very soon assumed twice its original size, became dark-blue in color and fluctuant to the touch. In this state the organ was returned.

Given 4 Cc. of Magendie's Sol.

Jan. 17. Appears feeble. Refuses food.

Jan. 18. Indifferent. Refuses food.

Jan. 19. Eats a few pieces of raw meat.

P. M. Dead. Kidney still marked with a deep blue, contused spot. The end was largely determined by exposure.

EXPERIMENT 20. Oct. 17. Medium size dog. Weight, 16.5 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol. The ball passed transversely through the medullary portion of the organ. The wound of entrance was small and the hemorrhage arrested therefrom by means of a silk suture. The wound of exit was large and stellate in appearance. Transverse suturing for the arrest of hemorrhage was unsuccessfully attempted. The purse suture was then applied and accomplished the desired end. This was reinforced by the implantation of omentum.

Given 4 Cc. of Magendie's Sol. and removed.

Oct. 18. Appetite fair. Appears lively.

Oct. 19. The same.

Nov. 20. Nephrectomy was practised upon the uninjured kidney.

Nov. 21. Refuses food.

Nov. 22. Eats and drinks.

Nov. 23. Same.

Jan. 3. Perfectly recovered. Killed for further examination.

P. M. The wound firmly repaired and apparently unchanged in size. Omentum adherent.

EXPERIMENT 21. Nov. 19. Small size dog. Weight, 4 kilograms. Kidney exposed and incised along its external border. This incision reached to a point about midway between the external border and edge of the pelvis. This was closed by a continuous silk suture. Good apposition and perfect hæmostasis was obtained.

Given 2 Cc. of Magendie's Sol. and removed.

Nov. 20. Up and appears lively. Eats hearty and is apparently unaffected by the operation.

Nov. 22. Same.

Dec. 26. Sacrificed for further examination.

P. M. Wound nicely united. Stitch visible beneath a layer of exudate.

EXPERIMENT 22. July 9. Small size dog. Weight, 7.5 kilograms. Anæsthetized. Spot selected in the linea alba shaved and disinfected. Six hypodermics of recently drawn urine were injected through this spot into the abdominal cavity.

Given 2 Cc. of Magendie's Sol. and allowed to come from under the anæsthetic. The animal showed evidences of uncomfört.

July 10. The posterior extremities weak and unsteady. This, passed away during the day.

July 11. Appears lively and takes food freely.

July 20. Recovered. Sacrificed for examination.

P. M. No signs of any adhesions visible.

EXPERIMENT 23. July 12. Small size dog. Weight, 5.5 kilograms. Kidney exposed and a triangular piece resected measuring 2 Cm. at its base and reaching almost into the pelvis. The surfaces were brought together by three deep interrupted catgut sutures and the edges approximated by a running silk stitch. The capsule was drawn over the raw edges and united by fine catgut sutures.

Given 2 Cc. of Magendie's Sol. and removed.

July 13. Appears fresh and at noon drank a small quantity of milk.

July 14. Appears lively and drinks milk freely.

July 28. Nephrectomy was practised upon the opposite kidney.

July 29. Refuses food.

July 30. Eats and drinks.

Aug. 5. Appetite good and appears hearty.

Sept. 2. Killed for further examination.

P. M. Kidney firmly united. Diminished considerably in size. Omentum adherent.

EXPERIMENT 24. Jan. 18. Medium size dog. Weight 17 kilograms. The left ureter was exposed through a lumbar incision and severely compressed with an ordinary hæmostatic forceps in a number of contiguous places.

Given 2 Cc. of Magendie's Sol.

Jan. 19. Up; eats and drinks and appears, if at all, very slightly affected.

Jan. 20. Same. Continued thus till Feb. 10th, when he made his escape.

EXPERIMENT 25. Jan. 18. Medium size dog. Weight 15 kilograms. Left ureter exposed through a lumbar incision and incised for a distance of 6 Cm.

Given 2 Cc. of Magendie's Sol.

Jan. 19. Refuses food and water.

Jan. 20. Same.

Jan. 21. Found dead.

P. M. Adhesions among the intestines and omentum. Here and there were scattered solid flakes of a yellow-purulent substance. Cavity contained 415 Cc. of bloody urine. Death from sepsis.

EXPERIMENT 26. Jan. 18. Small size dog. Weight 14 kilograms. Left ureter exposed and divided about 8 Cm. from the kidney. It was then noticed that the animal was pregnant and apparently near the full time.

Given 2 Cc. of Magendie's Sol.

Jan. 19. Found dead.

P. M. The abdominal cavity contained a large number of blood clots. There was but a small amount of fluid present. The tubes which contained the product of conception were empty.

Death was perhaps hastened by the absorption of the urine and the interference with pregnancy.

NEPHROLITHOTOMY.

Perhaps the most debated question relative to the operative attack upon the kidney, is the choice of the incision to be employed for its exposure.

Simple as it may seem, the convenient exposure of the kidney is nevertheless even under favorable conditions very often far from being an easy matter, and, where there is an accumulation of fat, a thickening of the abdominal wall, or where the circumrenal fat is present in large quantities and the kidney itself firmly bound down through a short pedicle, it is sometimes an extremely difficult matter to secure sufficient room for a thorough manipulation.

Quite a number of incisions have been recommended as furnishing accessible means of reaching the kidney.

Apart from the usual incision in the median line, either above or below the umbilicus, Langenbuch has recommended one in the *linea semilunaris*, which would be practically over the anterior surface of the organ.

Mr. Tait¹ is of the opinion that it matters very little, as regards the immediate success of the operation, whether it is attacked through the lumbar or the abdominal route.

Although he strongly favors the abdominal incision, should a nephrectomy become necessary, on account of the facility it affords for the examination of the opposite organ before proceeding to its removal, but for simple nephrotomy, the lumbar incision is preferable.

Kocher usually commences the incision immediately below the ensiform cartilage. König has practiced an L-shaped incision, commencing at the last rib and running parallel with the erector spinæ muscle to within a few centimeters of the os ilium. The incision then curves around anteriorly in the direction of the navel, ending about the external border of the rectus muscle, and if necessary even through this to the umbilicus. If the space is still insufficient, more room can be obtained by separating the peritoneum with the hand.

Newman favors the incision employed in Amussat's operation which he outlines by drawing a line from the center of the iliac crest to the free extremity of the last rib.

This line is intersected by another drawn through its center, commencing at the outer border of the erector spinæ forward for a distance of three, or three and a half inches. The wound is then carefully separated by the aid of two flat retractors. Mr.

¹Lawson Tait, Birmingham, Med. Rev., Sept., 1885.

Morris leans towards the lumbar incision in nephrotomy, while in nephrolithotomy he prefers an incision made four and a half inches in length, parallel with and three-quarters of an inch below the last rib. The structures divided being the same as in nephrotomy.

Mr. Knowsley Thornton has recommended a combination of both lumbar and abdominal incisions, under the name of the lumbo-abdominal nephrolithotomy, in which he employs the abdominal incision primarily for the purposes of exploration and diagnosis while secondarily a small lumbar incision is reserved for the extraction of the calculus.

After seeing the variety of incisions offered for the exposure of this organ, it goes without saying that the operative mind is yet far from being in concord upon this individual question, and, after all, the choice of the incision must finally be determined by the condition which prompts the interference and shapes the operation. In short, there are but two principal incisions, the others being but modifications of these. The abdominal incision, which may either be performed in the *linea alba*, or the *linea semilunaris*, and the lumbar incision, or a modification of this.

The comparative merits of these two methods may conveniently be summed up in the succeeding lines.

The principal advantages urged in behalf of the abdominal route, are :

First, the ease which it affords for determining the existence and condition of a second kidney.

Secondly, in the instance of large tumors, or where for some reason there is danger of considerable hemorrhage, the abdominal incision is more preferable by reason of the easy access and the extended space it offers for manipulation.

Thirdly, Mr. Newman, in speaking of Langenbuch's incision, remarks, "That the kidney is not only easily reached, but the large veins in the anterior layer of the meso-colon are avoided. Besides this it offers an excellent drainage, and is practically an extra peritoneal operation."

Touching upon the latter incision in nephrolithotomy, Mr. Thornton¹ recapitulates its advantages upon this point as follows :

¹Surg. of the Kidneys, J. K. Thornton, p. 36.

"We are certain that the patient has the usual allowance of kidneys. The chances of overlooking the stone, if there is one present in either kidney, are reduced to a minimum. I do not say that the abdominal handling is absolutely infallible, but in fourteen operations I have only once failed to find a stone, and the recovery and present health of this one patient, as already given in her own words, make it highly improbable that there was, or is, a stone in her kidney. This result compares very favorably with a large number of unsuccessful lumbar explorations already recorded. Greig Smith mentions twenty-five cases of unsuccessful lumbar explorations, *i. e.*, no stone could be found. There is no fear of cutting into the healthy kidney while the stone is in the opposite one—a serious accident which my cases demonstrate as liable to happen at any time by the lumbar method.

"There is no fear of accidental wound of either colon or peritoneum, because they are guarded by the hand in the peritoneum, while the kidney and stone are fixed, so that a small, clean cut upon the stone is all the damage inflicted upon the loin tissues. There is, consequently, infinitely less risk of extravasation of urine or of after-suppurating, and no risk of a loin hernia. There is the great advantage of ascertaining what is the condition of the other kidney and that of both ureters."

Continuing, this surgeon remarks: "What are the objections to be set against these advantages?"

"Simply the making of two cuts instead of one. The increased risk, due to the opening of the peritoneum, is practically nil, *i. e.*, if the surgeon will take the pains to perform a thoroughly aseptic operation. I quite admit that this is the key of the position. If there is to be risk of septic infection of the peritoneum, then the combined operation is not justifiable; but I maintain that with proper care the mere opening of the peritoneal cavity and the manipulations in it necessary to examine the state of the kidneys and ureters, and to aid the execution of the lumbar extraction, are practically free from risk—certainly as free from risk as a large wound made through the loin tissues by a surgeon who is not cleanly enough in his work to avoid danger of infecting the peritoneum."

Quoting the opinions of other operators this author adds: "Morris says: 'But should we, under these circumstances, be ever justified in examining both kidneys from within the abdomen, I think we should, if the patient be clearly going into a bad way, more especially if there have been at any time marked crystalline forms in the urine, and if a digital examination of the vesical ends of the ureters gives a negative result.'

"In 1887, Bruce Clarke mentioned, at the Clinical Society, a case in which, with the lumbar incision, an hour elapsed before even the kidney could be found, and he adds: 'It would have been wiser to perform an abdominal operation.' The patient died."

In his speech at Leeds, he gives details of a most interesting case, in which a failure, by simple lumbar nephrotomy, was changed into complete success, by the aid of a hand in the peritoneum.

Yet, in the same debate, Morris spoke of the absence of any difficulty in finding the kidney by lumbar incision, and of the freedom from fatality and misfortune in this procedure. I know of at least one other case which has happened since, at one of the large London hospitals, in which the surgeon failed entirely to find the kidney by lumbar incision.

Morris also said, "What was wanted was greater precision in diagnosis." Precisely, and this is what my combined method gives.

Howard Marsh, in speaking on another occasion at the Royal Medico-Chirurgical Society, said: "One point in renal surgery seemed to be coming to the front—that many stones could not be reached from the loin. Our progress seemed to be in the direction of admitting the wisdom of abdominal exploration."

Time and experience tend liberally to the importance of arriving at an early diagnosis and instituting prompt interference.

Procrastination in this means untold suffering for the individual and the steady increase of the dangers militating against the ultimate success of the operation.

The force of such a statement can only be realized after a survey of Mr. Newman's tables, in which the mortality of abdominal nephro-lithotomies for suppurative disease amounted to 83 per cent. and that of the lumbar at 39.6 per cent. Against this is

placed forty-two cases operated upon without suppuration with not a single death. These tables go further, in that they demonstrate the importance of the lumbar method where a suppurative process has already been established which is calculated to contribute to the infection of the peritoneum in the event of an abdominal operation.

While upon the subject of nephrectomy Thornton sums up the objections raised against the lumbar method, which, on the whole, bear a like relation as regards nephrolithotomy.

" 1. The small space available for incision in most cases

" 2. The danger of wounding a pleura with a low insertion.

" 3. The danger of wounding the colon or the peritoneum, and of fouling the latter, without being aware of the accident.

" 4. The possibility of not being able to find the kidney at all, an accident which has happened in a large number of cases, and to experienced London surgeons.

" 5. The possibility of removing a single kidney without knowing that the patient has only the one.

" 6. The impossibility of noting the condition of the other kidney and ureter.

" 7. The fact that it is only suitable for a limited number of cases, it being impossible to remove much-enlarged kidneys through any incision that can be confined to the loin.

" The great point advanced in its favor is that, up to the present time, it has been more successful than the abdominal method. Why? Simply because it has been the fashionable method, and the abdominal method has usually been a last resource in cases which were too bad to be operated upon by the lumbar method.

" Even so. Newman's tables show that there were twenty-one deaths in fifty-four fatal lumbar nephrectomies from shock and collapse, against twenty in sixty-six fatal abdominal nephrectomies from the same causes. I do not suppose any rational being will, in the present day, make the mere opening of the peritoneal cavity a reason against abdominal section and in favor of lumbar. Newman is undoubtedly right when he says: "If the relative position of the two operations were reversed, the mortality of the lumbar operation would be much higher than that of the abdominal one now is."

From the remarks of Thornton, which have so clearly and logically set forth the advantages and disadvantages of these respective incisions, it remains as a natural conclusion that in the vast majority of cases the abdominal is by far the most justifiable and philosophical operation.

The exceptions to which the lumbar method is addressed, are those in which for some reason there are grounds for suspecting the danger of infection of the peritoneum and the resulting consequences

The congenital absence of one kidney is very rare. Mr. Morris, after carefully searching the post-mortem records offers the following comparisons :

Of 4632 inspections made in the ten years ending in 1882, at Guy's Hospital, there occurred one congenital absence or undeveloped rudiment of one kidney.

Of 2610 inspections made at the Middlesex Hospital during the ten years ending in 1883, there was no case of congenital absence or undeveloped rudiment of one kidney.

Of 3800 inspections made at Bartholomew's during the ten years ending in 1884, there was no case of congenital absence or undeveloped rudiment of one kidney.

Of 936 inspections made at the Hospital for Children, Great Ormond, during the ten years ending in 1884, there was one case of congenital absence and one of extremely defective development.

These four sources make an aggregate total of 11,978 examinations with three cases of absence or of extreme atrophy of one kidney or of one in every 3992 $\frac{2}{3}$ cases.

In addition, Mr. Morris repeats the estimates of Weir and Petersen, the former placing this abnormality at 1 in 5000 cases, and the latter in one in 1500, the combining figures being two in 6500 bodies, or one in 3250. Jacobson¹ and others have pointed out the importance of counting the ribs in performing the lumbar incision. The necessity of observing this precaution is best felt, when it is remembered that the dissections of Hall have shown that the pleural cavity in sixty cadavers descended as low as the

¹ W. H. A. Jacobson.—Symptoms and Conditions which Justify Nephrolithotomy. *Br. Med. Jour.*, Jan. 14, 1890.

first lumbar vertebra, or where the last rib is wanting it descends as low as the ligamentous band that supplies its place.

Prof. Dumreicher accidentally opened a pleural cavity with a lethal result, in an attempt to remove a pyelo-nephrotic calculous kidney. At the post-mortem the last rib was found rudimentary, and the pleura projecting a considerable distance below the lower edge of the eleventh rib.

Lange,¹ who has made rather extended study upon this anatomical point, has demonstrated that the pleura reaches even lower along the spine.

The question of hemorrhage is another that has ever occupied the surgeon's mind in all operative attacks upon the kidney.

While the statement that the hemorrhage from this source is easily controlled through the use of gauze, is inclined to produce an impression underestimating the difficulty of the same, a study of a number of injected kidneys has firmly convinced the author that at least in a number of kidneys it would have been impossible to have made an incision of scarcely any depth without creating a hemorrhage far too great to be conveniently controlled by this measure.

The hemorrhage which occurred in many of the experiments has suggested the importance of a means which would provide a bloodless, or almost bloodless, operation. In the attempt to devise means for securing this end a variety of measures were tried, partly with the view of estimating their respective merits in securing a bloodless field, as well as determining their individual effect upon the coats of the renal artery. While a number of instruments affording different characters and degrees of compressions were employed, it was only in one instance in which there remained any ground for suspecting that an injury had been inflicted upon the arterial coats. In this a hard, wooden clamp was employed, with its blades very tightly applied by an assistant, who possessed an unusual degree of strength. Finally, a clamp was devised, armed at the extremity of its blades with two transverse segments, one of which was concave and the other

¹ Observations upon the Surgical Anatomy of the Kidneys with special reference to the twelfth rib, the Pleura, the Diaphragm, etc. Frederic Lange, *Annals of Surgery*, October, 1885.

convex. These were each covered with soft rubber tubing to moderate their effect upon the arterial coats.

Experience demonstrates the difficulty of securing, as well as retaining the renal artery. The groove was frequently too small for the artery, or the relation of the latter to the vein was such that almost as much of the vein was compressed as the artery, increasing rather than diminishing the hemorrhage. In lieu of

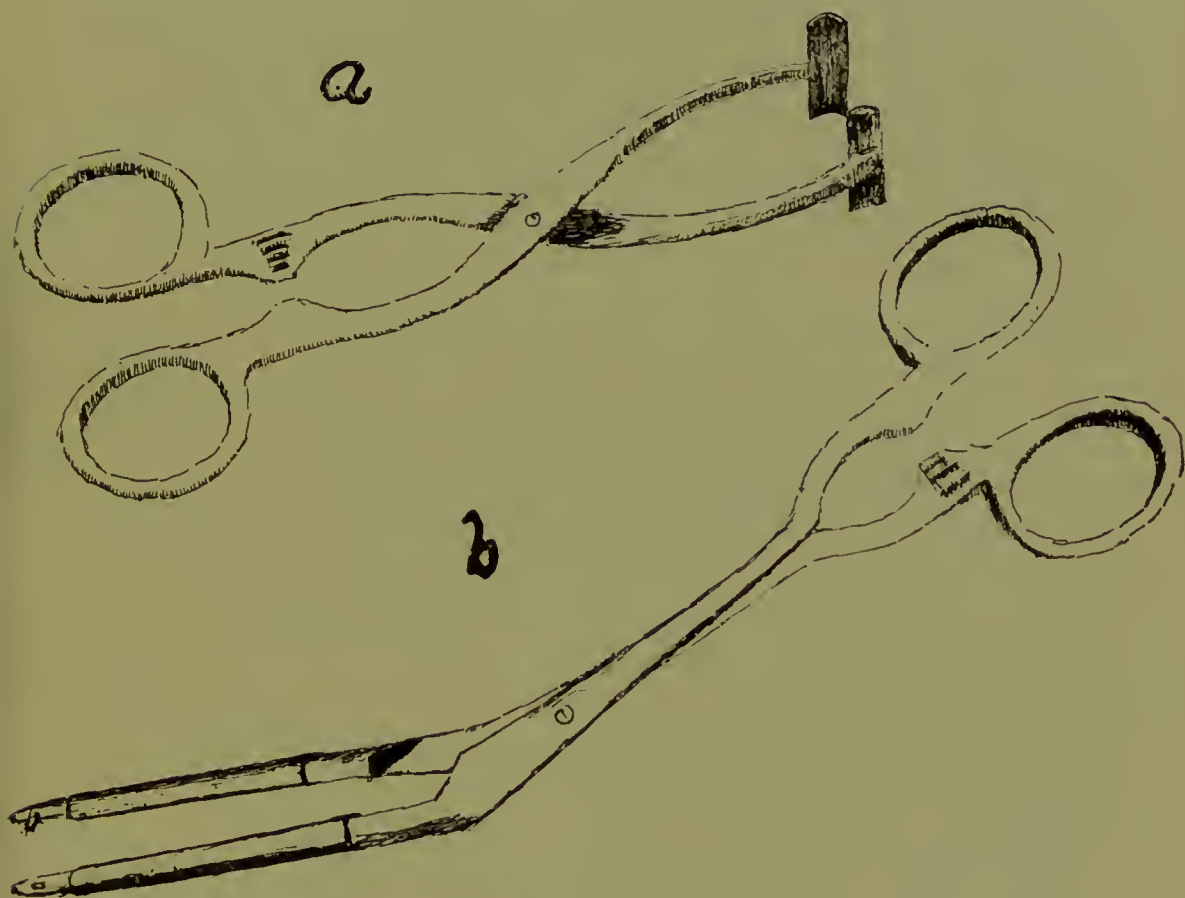


FIG. 7.—*a*, Imperfect clamp. *b*, Modified clamp for compressing renal artery.

this a modification of the latter, which included the whole renal root, was tried. In applying these forceps the ureter may, or may not, be included within the compression. When applied a distance of a few centimeters from the internal border the blades passed clear of this duct, since it describes a short curve in a downward direction soon after leaving the kidney. The instrument in question is fashioned after an ordinary forcep. The blades are rounded, one of which is armed upon the inner side of its extremity with a small blunt spine, while the opposite one is perforated for the reception of this small projection; the func-

tion of the same being to guard against the possibility of the forceps slipping away.

When in use, the tissues are protected from any possible violence by carefully covering the blades with soft rubber tubing. The pressure can be regulated by means of three small cogs arranged near the handles.

During the compression of the renal artery there is not only a cessation of the hemorrhage, but the secretion of urine also becomes arrested.

According to Littre and Robart a ligature of the renal artery for two or more hours causes a necrosis of the epithelial lining of the contorted tubes and glomeruli. The time, however,



FIG. 8.—Exploratory incision upon the external border.

required for the longest operation is not sufficiently lengthy to practically effect the kidney when rendered anæmic for such a purpose.

After the kidney has been subjected to a thorough examination by means of careful palpation and thorough exploratory punctures with the needle, with a negative result as to the location of the calculus, its interior can then be exposed through an incision for a closer inspection. Should, however, a stone be located an incision performed over its greatest prominence is to be selected. Where no such a guide is at hand there are a variety of incisions that may be employed. The organ may be laid open through one made in the external border, or through one made in its transverse axis, or through one into the kidney proper just above the pelvis, or, lastly, through the pelvis itself.

As for the choice of these a great deal will depend upon the attending circumstances. An incision through the kidney struc-

ture, whenever practicable, is always preferable to one made through the pelvis itself, since the kidney structure not only heals more kindly than the pelvis, but, in view of its thickness, it is less liable to be complicated with resulting fistulous tracks. As for the respective merits of the other incisions, the transverse is, perhaps, the least desirable should a deep incision become necessary, since it affords but a limited access to the interior of the organ, unless it is carried to such an extent that would seriously jeopardize the safety of the organ. The selection of the incision, in the absence of a direct guide obtained either through palpation or an exploratory puncture, is between one in the external border and one made just above the pelvis.



FIG. 9.—Exploratory incision through the transverse axis of the kidney.

The practical difference between these two incisions is that the one above the pelvis necessitates the division of less renal structure, and while it is a closer route to the pelvis it is nevertheless questionable whether it affords the most thorough exploration of the same. Because of its transverse nature it not only exposes but severs the calyces and all the vessels of one side for the length and depth of the incision.

Although the incision performed upon the external border is through a much deeper layer of renal tissue, it affords not only a thorough exploration of the entire pelvis, but is also a favorable one for closure and repair. Its course being rather in the direction of the vessels and calyces, it allows an examination of the latter with as little as possible injury to the same.

The respective merits of these two incisions can only be determined after having been subjected to a more extended application.

Before the closure of the incision is undertaken, the kidney should be carefully freed of all clots that may have accumulated from the contained blood, the cavities thoroughly irrigated, and, unless otherwise indicated, securely closed by deep and superficial sutures, as already indicated under injuries.

If there is any available structure surrounding the kidney this can be carefully drawn over the same to reinforce the closure.



FIG. 10.—Exposure of the pelvis through a semi-lunar incision.

If an incision into the pelvis be undertaken it should be closed by the Czerny or double suture to more thoroughly guard against the occurrence of a fistulous track.

These are but additional remarks which are not intended to replace a more extended analysis of the details of this important subject.

EXPERIMENTAL OPERATIONS UPON NEPHROLITHOTOMY.

EXPERIMENT 27. Oct. 21. Large size dog. Weight 24 kilograms. Left kidney exposed and the pelvis laid open by a semi-lunar incision made at one-third distance from internal border. This incision allowed a thorough exploration of the entire pelvis and the commencement of the ureter. The wound was closed by means of deep interrupted sutures of catgut that were immersed in tincture chloride of iron. The superficial edges were approximated by means of interrupted silk stitches. This afforded a perfect apposition. The surface was then covered with an apron of omentum. The whole organ was thoroughly irrigated with warm, sterilized water and replaced.

Given 4 Cc. of Magendie's Sol. and removed. Reaction followed promptly.

Oct. 22. Takes food.

Oct. 23. Appears lively.

EXPERIMENT 28. Dec. 2. The same dog used in previous experiment served for the present. The animal had entirely recovered and was ready for a second operation. The opposite kidney was exposed and its pelvis opened by an incision across the short axis of the organ. The lateral edges of the incision being more superficial than its central portions which extended down into its pelvis. This incision rendered the commencement of the ureter visible and allowed a complete exploration of the entire pelvis of the kidney. This operation was far more bloody than the preceding. The surfaces were apposed by deep sutures of catgut that had been immersed in tincture of iron. The superficial edges were brought together by interrupted silk sutures. The organ was irrigated with sterilized water and returned.

Given 4 Cc. of Magendie's Sol. and removed.

Dec. 3. Refuses food. Appears very thirsty.

Dec. 4. Same.

Dec. 5. Appetite improved. Thirst diminished.

Dec. 23. The animal met with an accident which resulted in its death.

P. M. The kidney upon which the lateral incision was practiced was found firmly united. Upon section a yellowish cicatricial tissue which represented the bond of union, was exposed. Upon exposure of its interior a few flakes of yellowish purulent matter were found. The kidney upon which transverse section was practised was found not as firmly united. The edges partly gaping. No adhesions upon this kidney.

EXPERIMENT 29. Nov. 3. Small size dog. Weight 8.5 kilograms. Kidney exposed and laid open with a bold incision through the short axis of the organ reaching to its pelvis.

This afforded a thorough examination of the pelvis and ureter. The kidney was closed by three deep sutures of ferrated catgut. The edges of the incision were approximated with interrupted silk sutures. This afforded perfect apposition with but a small amount of hemorrhage. The operation was made practically bloodless by a digital compression of the renal artery. The animal soon rallied.

Nov. 4. Walks about, but refuses food.

Nov. 5. Appetite improved.

Nov. 6. Eats well. Appears lively.

Nov. 7. Refuses food.

Nov. 8. Found dead.

P. M. Cavity clean; no adhesions. The divided edges rounded, patulous and in a sloughing condition. Catgut remained unchanged.

EXPERIMENT 30. Nov. 3. Large size dog. Weight 23 kilograms. Kidney exposed and compressed by means of a digital compression. The pelvis was laid open by an incision made into its external border extending from one to the other extremity. This afforded an excellent view of the interior of the organ. The kidney was brought together by means of six deep interrupted sutures assisted by superficial silk stitches.

Given 4 Cc. of Magendie's Sol. and removed.

Nov. 4. Walks about. Appetite good and appears lively.

Nov. 5. Same.

Nov. 6. Appetite diminished and seems to be losing ground.

Nov. 7. Diarrhœa. Mucoid stools streaked with blood.

Nov. 8. Gradually wasting. Appetite diminished.

Nov. 9. Same.

Nov. 10. Condition unchanged.

Nov. 11. Appetite better.

Nov. 12. Diarrhœa diminished and appetite improving.

Nov. 13. Improving.

Dec. 29. Appears lively. Diarrhœa has ceased for more than three weeks. Gained apparently some in weight.

Killed.

P. M. The incised kidney contracted to almost half its original size. The line of union firm. Omental adhesions throughout the entire incision.

EXPERIMENT 31. Nov. 17. Medium size dog. Weight 18.5 kilograms. Kidney exposed and rendered bloodless by digital compression. Pelvis and ureter laid bare by an incision through the short axis of the organ. Central portion of the incision being deeper than the lateral. After thorough exploration of the pelvis the wound was closed by deep interrupted sutures of ferrated catgut and the superficial edges by means of silk stitches.

Given 4 Cc. of Magendie's Sol. and removed.

Nov. 18. Appetite good. Appears lively.

Nov. 19. Same.

Dec. 18. The dog made an uninterrupted recovery.

Reclaimed.

EXPERIMENT 32. Nov. 20. Small size dog. Weight 13 kilograms. Kidney exposed and rendered bloodless by digital compression. Pelvis laid bare by transverse incision, as in the preceding experiment. The incision was closed by deep interrupted sutures introduced near the

extremities of the organ and the edges brought together by a second row of superficial stitches.

Given 4 Cc. of Magendie's Sol. and removed.

Nov. 21. Takes food and water, but appears quite weak.

Nov. 22. Improved.

Nov. 23. Good appetite. Appears active.

Jan. 3. Recovered. Killed to obtain the specimen.

P. M. Kidney slightly contracted. Omentum adherent.

EXPERIMENT 33. Nov. 20. Medium size dog. Weight, 14 kilograms. Kidney exposed and rendered bloodless by digital compression. The pelvis and ureter were laid bare by an incision into the long axis to the extent of one-half the length of the organ. The incision was closed by four deep sutures passed around almost the entire organ. The superficial edges were brought together by interrupted silk sutures. Given 4 Cc. of Magendie's Sol. and removed.

Nov. 21. No food. Quite thirsty and very weak.

Nov. 22. Slightly improved.

Nov. 23. Takes a small quantity of finely-chopped meat.

Nov. 24. Appetite better, but still weak.

Dec. 11. Eats well and appears hearty. Disappeared.

EXPERIMENT 34. Nov. 23. Medium size dog. Weight, 15.5 kilograms. Kidney exposed and pelvis laid bare by a semilunar incision made one-third above its internal border. This operation was rendered bloodless through the application of a wooden clamp applied to the artery. Before closure of the incision the pelvis was carefully irrigated and freed from all remaining blood clots. The incision was closed by means of deep interrupted and superficial silk sutures. Given 4 Cc. of Magendie's Sol. and removed.

Nov. 24. Refuses food. Takes a few ounces of water.

Nov. 25. Took a few pieces of meat.

Nov. 26. Looks dull, appears weak, slight appetite.

Nov. 27. Quite weak. Takes a small quantity of meat. Very thirsty.

Jan. 10. Killed for further examination.

P. M. Firm union. Slightly contracted as compared with the opposite kidney. Omentum adherent.

EXPERIMENT 35. Nov. 23. Large size dog. Weight 26.5 kilograms. Kidney exposed and the pelvis laid bare by a semi-lunar incision into its side. The incision was made about half way between the internal and external borders. The operation was only partially bloodless,

owing to imperfect digital compression. After irrigation of the pelvis and the removal of most clots, the incision was closed by the use of deep and superficial interrupted silk sutures. Given 4 Cc. of Magendie's Sol. and removed.

Nov. 24. Eats raw meat and drinks a large quantity of water which he soon vomits.

Nov. 25. Refuses food.

Nov. 26. Very thirsty. Takes but a small quantity of meat.

Nov. 27. Very weak.

Nov. 28. Same.

Nov. 29. Found dead.

P. M. Abdominal cavity contained about 350 Cc. of clotted blood. No adhesions. Renal wound gaping and of a softened appearance. Death from secondary hemorrhage.

EXPERIMENT 36. Nov. 27. Large size dog. Weight 22 kilograms. Kidney exposed and rendered bloodless by compressing the renal artery with a hæmostatic forceps, the blades of which were protected by covering with a piece of rubber-sheeting. The pelvis was explored through asemit-lunar incision made into the side of the organ. The incision was closed with a series of deep interrupted and superficial stitches. Given 4 Cc. of Magendie's Sol. and removed.

Nov. 28. Eats and drinks.

Nov. 29. Same.

Nov. 30. Improving.

Jan. 12. Sacrificed for further examination.

P. M. Incised surface firmly united and marked by an adhesion of the omentum, intestine and spleen. Upon section, the interior of the kidney partially destroyed. The deep sutures were visible and seemed slightly softened and enlarged.

EXPERIMENT 37. Nov. 27. Medium size dog. Weight 15.5 kilograms. Kidney exposed and rendered bloodless with a hæmostatic forceps as in the preceding experiment. An absolutely bloodless incision was made after the same fashion as in the preceding operation. The incision was closed by three deep interrupted silk sutures and a number of superficial stitches. Given 4 Cc. of Magendie's Sol. and removed.

Nov. 28. Takes a small quantity of raw meat.

Nov. 29. Same.

Nov. 30. Improved.

Nov. 31. Lively. Eats some raw meat. Continued thus in a very fair condition until Dec. 7, when he was exposed to cold.

Dec. 8. Refuses food and appears unwell.

Dec. 9. Found dead.

P. M. Adhesions upon the incised surface. The kidney somewhat disorganized and filled with a gelatinous pus. Death from nephritic abscess.

EXPERIMENT 38. Nov. 30. Small size dog. Weight 11.5 kilograms. Kidney exposed and pelvis explored through a lateral incision. The operation was made bloodless by compressing the renal artery with a specially prepared clamp. The wound was closed by a number of deep and superficial interrupted stitches. Given 4 Cc. of Magendie's Sol. and removed.

Nov. 31. Appetite fair.

Dec. 7. Eats hearty and appears comfortable.

Jan. 6. Apparently recovered. Good appetite, and appears lively. Sacrificed for further examination.

P. M. Kidney united. Omentum, spleen and intestines adherent.

EXPERIMENT 39. Nov. 30. Medium size dog. Weight 14.5 kilograms. Kidney exposed and pelvis explored through an incision similar to that in the preceding experiment. The operation was bloodless and completed in the same manner as in the foregoing. Given 4 Cc. of Magendie's Solution and removed.

Nov. 31. Refuses food.

Dec. 1. Took a small quantity of milk.

Dec. 2. Improved.

Dec. 3. Eats hearty and appears lively.

Jan. 6. Sacrificed for further examination.

P. M. Kidney firmly united, slightly depressed and apparently diminished in size. Omentum adherent.

EXPERIMENT 40. Nov. 19. Small size dog. Weight 4 kilograms. Kidney exposed and incised along its external border. This incision reached to a point about midway between the external border and edge of the pelvis. This was closed by a continuous silk suture. Good apposition and perfect hæmostasis was obtained. Given 2 Cc. of Magendie's Solution and removed.

Nov. 20. Up; appears lively; eats hearty, and is apparently unaffected by the operation.

Nov. 21. Same.

Dec. 26. Sacrificed for further examination.

P. M. Wound nicely united. Stitch visible beneath a layer of exudate.

NEPHRORRHAPHY.

Since the publication of nephrorrhaphy by Hahn in 1881, this operation, on the whole, has practically lost none of its original identity. The only effect which the last decade has occasioned in this direction has been the addition of different materials to be employed for its fixation, together with a few modifications which have added to the security of its attachment.

We must confess that it still remains for the future to offer measures which insure more certainty in these cases. The important questions in this connection which divide the surgical mind are the selection of the most desirable suture material and the decision as to the attachment which offers the greatest permanency in reattaching the displaced kidney.

As for the first, a variety of material has been recommended, *e. g.*, silk, cat-gut, silk-worm gut, silver wire and kangaroo tendons. So far as the preference in the selection goes, that, as yet largely depends upon the individual opinion of the operator.

Many favor cat-gut alone. Some a number each of cat-gut and silk-sutures, while a very large per cent. select the silk which experience has amply proven to be innoxious, besides having the advantage of offering more permanency in its fixations. Bearing upon the different methods of securing its attachment. Dr. McCosh¹ upon this same subject has represented the four available methods which have already been resorted to.

" 1. The adipose capsule, opened or unopened, is united by sutures to the edges of the incision.

" 2. After freely opening the adipose capsule, the sutures are passed through the fibrous or true capsule of the kidney.

" 3. After the free exposure of the kidney, the sutures are passed directly through its parenchyma.

" 4. A certain portion of the capsule proper is stripped off the kidney, and the sutures passing through its parenchyma

¹The surgical treatment of movable kidney, A. J. McCosh, N. Y. Med. Jour., March 15th, 1890.



FIG. 1

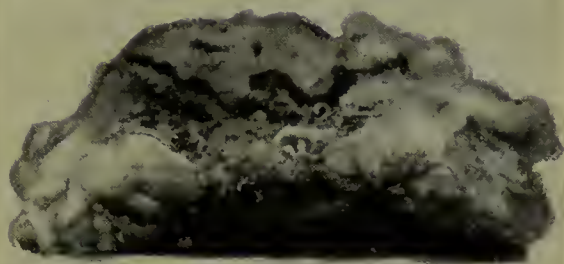


FIG. 2



FIG. 3



FIG. 4

FIG. 1.—Destructive internal changes following an exploration.
 FIG. 2.—Ulcerated exterior resulting from a peri-nephritic suppuration.
 FIG. 3.—Frozen section of an implanted kidney.
 FIG. 4.—Frozen section from within of an implanted kidney.



bring the raw surface, thus made directly in contact with the cut tissues of the loin. The sutures enter and emerge through the capsule just outside the raw margin and are then passed through the tissues on each side of the incision which is closely united."

Apart from the main outlines here represented, there is yet a vast amount of detail which different operators have variously recommended.

A number of experiments were performed with the hope of devising a method which would offer more certainty or perhaps take the place of nephrectomy in the more rebellious variety of these cases.

The sutures were replaced by natural stays, in the shape of a pocket, formed between the transversalis and internal oblique muscles. The attempt in the beginning was very unsuccessful, the cause of which was later found not to be dependent upon a muscular compression, but to a traction upon the root of the kidney, especially when the operation was performed upon the right side. It was noticed that in every instance the left kidney was always more or less movable as compared with the right, and where the latter was selected it was always followed with an early death, dependent upon a traction of its root. With the exception of one or two, the implantations upon the left side were all successful. In the excepted cases, the death was not dependent upon compression, but rather to the effects of sepsis consequent to an imperfect drainage.

The experiments were mostly performed in the lumbar region, some however, were also performed through the abdominal route. In some the circumrenal structures were left undisturbed, the kidney being thus implanted in its new location, whereas in others all but the capsule were removed. In a few this was also stripped off, leaving the raw surface behind. On no occasion was the slightest evidence to be observed of any evil effect from the compression of the kidney.

When the kidney in its raw state was implanted, the whole organ became adherent, whilst if the circumrenal tissues were left, they alone became attached, whereas the kidney itself remained free within its surrounding structures.

The divided edges of the transversalis muscle were either brought in contact, or they were loosely sutured with the space of about one centimeter intervening.

In either event the edges finally united by a firm cicatrix.

In two of the experiments this principle was thoroughly tested as to its feasibility, at least in lower animals.

Soon after the kidney was successfully implanted the opposite one was removed in order to more fully determine the value of the implanted kidney.

In one, the animal was allowed to live about two and a half, while in the other, it lived about three and a half months, during the whole of this time upon the single implanted kidney.

Throughout the whole of this period there were absolutely no signs to be noticed of any discomfort whatever; the animals appeared lively, gained in weight, and, in short, presented a first-class condition. Externally the outlines of the organ were scarcely discernible and manipulation gave rise to no discomfort to the animal.

After the animal was sacrificed, the kidney in each was found nonadherent, the circumrenal tissues alone being attached to the adjacent sides of the muscle.

The organs were further submitted to a microscopical examination, in which it was observed that the capillaries were somewhat enlarged, a slight fatty infiltration and a granular degeneration of the cortex, limited, however, to the peripheral cortex alone.

The deep tubes and epithelium were normal.

A number of studies were made upon cadavers, with the intention of utilizing this upon the human subject.

The space between the last rib and the iliac crest is hardly sufficient to admit of a safe implantation.

In a few sufficient room might be obtained for its implantation, yet the space is shortened by different positions of the body, which would seriously interfere with its safety. There is another region which would be perhaps better adapted for the reception of the organ than the abdominal wall.

The *psoas magnus* muscle can be divided near its external edge, in such a manner as to afford a thin muscular lamella, which forms the outer wall of a pocket.

In a few the muscle was large enough to furnish a pocket of sufficient size to completely hold the organ, while in others this end was only partly accomplished. Where the pocket was large

enough, the edges of the muscle were reunited over the inner border of the organ, leaving a suitable provision for its root, or where it was insufficient the edge of the muscle was united with the surface of the kidney itself. Should this upon further consideration assume a feasible aspect, it would only address itself

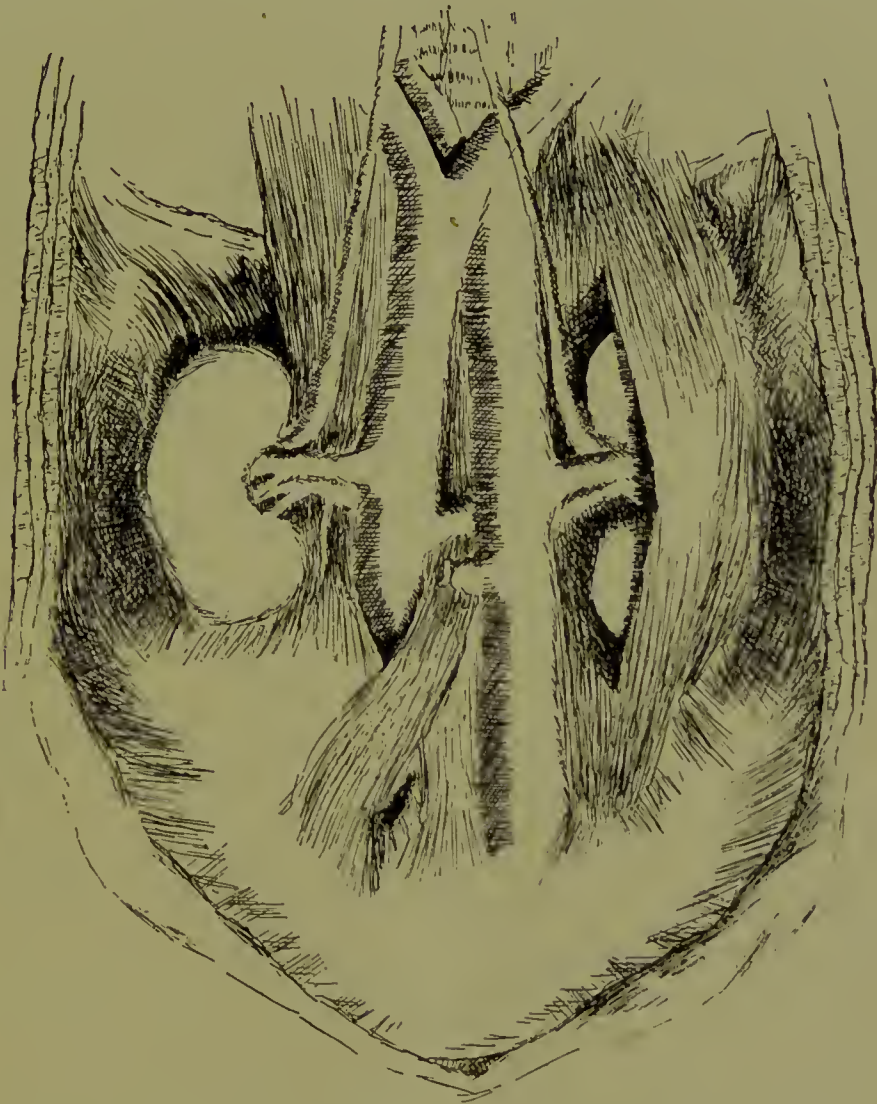


FIG. II.—Showing the kidney implanted between the fibres of the psoas magnus muscle.

to those cases where other methods had failed and this adopted as a *dernier resort* before recourse is had to nephrectomy.

Again, it could not be employed in every case, since this muscle in a number of cadavers was markedly insufficient to answer the purpose. It is also to be observed in dividing the muscle to cut clear of the vertebra, which insures a soft wall upon the inner side and a yielding one upon the outer side.

Besides this, care should be observed as to the depth of the incision, to avoid the lumbar plexus of nerves and lumbar arteries.

However Utopian this may seem in lower animals, we must be slow and careful in exercising boldness based upon experience gathered in this manner from the experimental field. The fact that many steps are feasible in lower animals that would be far from permissible in the human subject has not escaped the author's observation. And in offering this suggestion it is more with the hope that others more fitted than myself might enlarge upon whatever value it possessed, rather than the expectation of its feasibility or adoption in its present undeveloped state.

EXPERIMENTAL OPERATIONS UPON NEPHRORRAPHY.

EXPERIMENT 41. Aug. 10. Small size dog. Weight 4 kilograms. Median laparotomy. The kidney was drawn forward and freed of all the circumrenal structures. An incision of about 3 Cm. in length was made in the transversalis muscles parallel with its fibres.

A pocket was formed by dissecting the transversalis away from the oblique muscle by means of the finger-nail. The kidney was deposited into this pocket in such a manner that the long axis of the organ was at right angles with the fibres of the transverse muscle. The divided edges of the transversalis muscle were united by a continuous catgut suture and the abdomen closed.

Given 4 Cc. Magendie's Sol. and removed.

Seen few hours after the operation, the outlines of the kidney plainly visible externally and occasionally muscular twitching.

Aug. 11. Refuses food and seems unable to stand.

P. M. Died. Abdominal cavity contained 225 Cc. of bloody fluid. No adhesions. The parietes glazed with lymph.

Death from the effects of traction upon the root of the kidney.

EXPERIMENT 42. Aug. 12. Small size dog. Weight, 7 kilograms. The same operation as in the previous experiment was performed in this, differing only that in this the incision was made directly in the loin of place of the linea alba. The incision of each layer was made parallel with the long axis of the body, excepting the transversalis muscle, which was made in the direction of its fibres. The kidney was deposited in this pocket and the edges of the transversalis drawn within one Cm. of approximation. The other layers were each carefully closed over the implanted kidney.

Given 4 Cc. of morphia hypodermically and removed.

Aug. 13. Presents a somewhat dull appearance and refuses food. Unsteady walk.

Aug. 20. Eats and drinks heartily. Some of the stitches were torn out and the wound slightly gaping.

Aug. 28. Appears lively; eats and drinks. The wound entirely healed excepting the skin and second layer, which were still gaping.

Aug. 25. Wound almost united. Nephrectomy was practiced upon the other kidney, but the animal died from the chloroform just as the external wound from this was being closed.

P. M. The implanted kidney was found firmly imbedded and somewhat adherent. The edges of the transversalis were almost covered with omental adhesions.

EXPERIMENT 43. Aug. 18. Small size dog. Weight, 4 kilograms. Median laparotomy.

Both kidneys were carefully drawn into view and freed of all their circum-renal structures, including even the capsule of the organ. The kidneys presented a raw exterior and in this state they were replaced into the abdominal cavity. Cavity closed and given 2 Cc. of Magendie's Sol.

Aug. 19. Walks about, but refuses food.

Aug. 20. Lively; eats and drinks heartily.

Aug. 22. Appears well; eats and drinks heartily. The animal has assumed a very drawn up appearance.

Sept. 5. Same. Continues in the same deformed attitude. Killed for further examination. The kidneys were found movable and completely covered by adherent omentum.

EXPERIMENT 44. Sept. 13. Small size dog. Weight, 9 kilograms. The left kidney was exposed through a lumbar incision and with as little disturbance as possible to its surrounding structures implanted into a pocket formed between the transverse and internal oblique muscle; the overlying structures were carefully closed, layer after layer, by continuous sutures.

Given 4 Cc. of Magendie's Sol. and removed.

Sept. 14. Walks about and shows very little evidence of discomfort; drinks largely of water, but refuses food.

Sept. 15. Refuses food and water.

Sept. 16. Found dead.

P. M. The cavity contained 150 Cc. of purulent fluid, the kidney apparently unaffected by compression. Slight adhesions.

Death from sepsis.

EXPERIMENT 45. Sept. 13. Medium size dog. Weight 13 kilograms, Median incision, exposing the kidney. A pocket was formed by incising the transversalis at right angles to the course of its fibres. The kidney was implanted into this pocket and the transversalis carefully drawn over the edge of the organ to the extent of 1 Cm., and fixed there by continued silk suture introduced into the kidney structure. Slight hemorrhage from the renal stitches. The cavity was cleansed and closed. Given 4 Cc. of Magendie's Sol. and removed.

Sept. 14. Walks about. Takes water and milk.

Sept. 15. Same.

Sept. 16. Dead.

P. M. Cavity contained 200 Cc. of sero-purulent fluid. The line of union seemed perfect, but upon dissection two small abscesses were found communicating with the stitches. Slight adhesions. Death from sepsis.

EXPERIMENT 46. Sept. 30. Small size dog. Weight 4.6 kilograms. Medium laparotomy exposing kidney. This was separated from its perirenal structures and anchored beneath a ribbon-like strip of the transversalis muscle. The greater omentum was likewise drawn beneath this muscular band and made to envelop the kidney. The omentum and the kidney were reinforced with a few silk stitches. Cavity sponged and closed. Given 4 Cc. of Magendie's Sol. and removed.

Oct. 1. Walks about; refuses food.

Oct. 2. Same.

Oct. 3. Dead.

P. M. Abdominal cavity contained 75 Cc. of thin, sanguineous fluid. The kidney firmly fixed and covered with adhesions. Death from traction.

EXPERIMENT 47. Oct. 7. Small size dog. Weight 6.5 kilograms. Kidney exposed and found to be very movable. This was implanted between the internal oblique and transversalis muscles. The perirenal structures were left undisturbed, and in closing the transversalis muscle were included in the stitch. The oblique muscles were each carefully closed by distinct rows of sutures, followed by the superficial structures. Given 4 Cc. of Magendie's Sol. and removed.

Oct. 8. Walks about with unsteady gait. Refuses food.

Oct. 9. Eats and drinks. Shows no sign of discomfort.

Oct. 10. Same.

Nov. 13. Anæsthetized preparatory to the removal of the unimplanted kidney. The anæsthetic, however, was pushed with a fatal effect.

P. M. The implanted kidney firmly imbedded and of a normal appearance.

EXPERIMENT 48. Oct. 9. Medium size dog. Weight 5.5 kilograms. Kidney exposed and implanted into the abdominal wall between the internal oblique and transversalis muscles. The perirenal structures were preserved and included in the stitch employed for the closure of the transversalis muscle. The kidney was steadied by single stitch introduced into its external border.

Given 4 Cc. of Magendie's Sol. and removed.

Oct. 10. Eats freely. Appears able to walk but a short distance. Passes bloody urine.

Oct. 11. Eats freely and appears hearty.

Oct. 12. Same.

Oct. 13. Refuses food, but drinks a large quantity of water.

Oct. 14. Found dead.

P. M. Cavity contained 55 Cm. of sanguino-purulent fluid; few adhesions. Cavity dotted here and there with flakes of yellowish-green curds. Kidney bathed in pus and somewhat softened. Death from sepsis, arising apparently from the lumbar wound.

EXPERIMENT 49. Oct. 24. Medium size dog. Weight 21 kilograms. Left kidney exposed and implanted into the abdominal wall between the oblique and transversalis muscles. The overlying layers were each closed by separate rows of sutures.

Given 4 Cc. of Magendie's Sol. and removed.

Oct. 25. Refuses food.

Oct. 26. Eats and drinks.

Oct. 27. Same.

Nov. 7. Lively. Takes food freely and apparently recovered.

Nov. 12. Nephrectomy was performed upon the opposite kidney. In its removal the ligature slipped and a furious hemorrhage ensued. The vessel was again found, but only after the original incision was very much enlarged.

Given 4 Cc. of Magendie's Sol. and removed.

Nov. 13. Very weak. Refuses food.

Nov. 14. Improved.

Nov. 15. Eats heartily.

Jan. 26. Dog lively. Has gained in weight and suffers absolutely no inconvenience from his condition. External manipulation gave no pain whatever. The outlines of the kidney were indistinctly made out. Killed for further examination.

P. M. Kidney imbedded between the abdominal muscles, but the peri-renal structures alone were adherent. The kidney was free and devoid of adhesions and showed upon section no evidence of compression.

. EXPERIMENT 50. Sept. 10. Large size dog. Weight 16 kilograms. Left kidney exposed and implanted between the transverse and oblique muscles. The circum-renal tissue was left undisturbed and in drawing the divided edges of the transverse muscle together the tissues about the root of the kidney were included in the stitches.

Given 4 Cc. of Magendie's Sol. and removed.

Sept. 11. Takes food and shows very little signs of the operation.

Sept. 12. Eats and drinks.

Oct. 15. Appetite good. External wound healed with the exception of a small sinus. The unimplanted kidney removed.

Oct. 16. Takes food and water.

Oct. 17. Appears lively.

Jan. 26. The animal appears well, eats heartily and has gained in weight.

The outlines of the kidney can be imperfectly made out by palpation. Killed for further examination.

P. M. The kidney loose and lies unaffected in its new position. The circum-renal tissues attached to the adjacent sides of the muscles. Upon section, the transverse muscle separates, exposing a portion of kidney free of all adhesions.

EXPERIMENT 51. Nov. 5. Small size dog. Weight 9.5 kilograms. Left kidney exposed and implanted between the abdominal muscles as in the preceding experiment. Given 4 Cc. of Magendie's Sol. and removed.

Nov. 6. Walks about. Takes food freely.

Nov. 7. Same.

Nov. 16. Appears lively; eats well and apparently recovered. The unimplanted kidney removed.

Nov. 17. Appears lively. Eats and drinks.

Nov. 18. Same.

Nov. 20. Death from an accident occurring during the removal of the animal to other quarters.

P. M. The implanted kidney unaffected and firmly attached in its new position.

EXPERIMENT 52. Nov. 7. Small size dog. Weight 7.5 kilograms. Left kidney exposed and implanted in the abdominal walls. Given 4 Cc. of Magendie's Sol. and removed.

Nov. 8. Refuses food. Drinks a few ounces of water.

Nov. 9. Eats and drinks.

Nov. 10. Same.

Nov. 28. Appears hearty. Eats freely. Anæsthetized preparatory to the removal of the remaining kidney. During this, the anæsthetic was pushed with a fatal effect.

P. M. The implanted kidney firmly imbedded. No evidence of any pressure visible.

EXPERIMENT 53. Dec. 21. Same dog used in this that served in experiment 14. The uninjured kidney was exposed through a lumbar incision and deprived of its capsule and circumrenal structures. It was now thoroughly enveloped in the folds of the great omentum and thus sutured to the abdominal wall. Given 2 Cc. of Magendie's Sol. and removed.

Dec. 23. Same.

Dec. 24. Took a few ounces of milk, looks dull and lies quietly in one place.

Dec. 25. Same.

Dec. 26. Improved.

Dec. 27. Appetite better and appears stronger.

Jan. 5. Still presents a dull appearance. Appetite varying and rather weak. The external wound had largely healed.

Jan. 29. The external wound had entirely healed excepting one fistulous track, which at times discharged a purulent fluid. From the last to the present date the animal would eat well for a time while the fistula would be discharging, when this closed up the animal refused to eat, appeared drowsy and gave evidence of the absorption of septic matter.

Feb. 13. Dead.

P. M. The kidney that had been shut was firmly healed. The other was enclosed in an abscess cavity which communicated with the exterior through a fistulous track. The walls of the cavity were formed by the attached omentum upon the inner side and the abdominal wall upon the outer side. The kidney itself presented upon its exterior a worn and ulcerated surface.

Death from peri-nephritic suppuration.

RÉSUMÉ.

As deductions from the foregoing, I beg to submit for further consideration the following conclusions :

INJURIES OF THE KIDNEY.

(1) The disproportion which frequently exists between the cause and the effect in injuries of the kidney can alone be explained upon its peculiar anatomical structure, its physiological function and the frequency with which this organ is found in a more or less abnormal condition at the time of the accident.

(2) The external damage offers no safe criterion as to the extent of the internal injury.

(3) However slight the injury may seem, no definite conclusion can be reached as to its extent or its ultimate termination.

(4) In view of the uncertainty which ever surrounds the diagnosis of conditions in regions remote from the ocular inspection or the digital touch the prognosis should always be guarded.

(5) The sequelæ which frequently attend even trivial injuries should be kept carefully in view in rendering our prognosis and shaping our treatment.

(6) In all operative attacks upon the kidney, the capsule and perirenal structure should be preserved as carefully as possible, since these not only add to the strength of the purchase, but afford additional protection against hemorrhage and sepsis.

(7) A gun-shot injury amounting to a simple perforation is best controlled by the application of a "purse-string suture" to both orifices.

(8) This may be reinforced by a covering of peri-renal structure drawn together in a similar manner.

(9) The hemorrhage from superficial lacerating wounds of the kidney can confidently be arrested in the majority of instances by means of a single or double purse-string suture, applied one Cm. or more from its edge.

(10) The great omentum can frequently be employed as a valuable adjuvant in controlling the hemorrhage and in adding to the safety in many operations upon this organ.

(11) Incised wounds whose aseptic nature is questionable are best treated by tamponade and drainage through the loin.

(12) Wounds of the pelvis should be closed with a double row of sutures, as an additional measure against the formation of a fistula.

(13) Unless the wound of the ureter is singularly slight as compared to the size of the duct, nephrectomy is, as a rule, indicated as the most practical step.

(14) The incision in partial resection for the relief of an injury should be made distant from the contused region to insure the apposition of two healthy renal surfaces.

NEPHROLITHOTOMY AND NEPHRORRAPHY.

(1) The choice of the incision in all operative attacks is largely to be determined by the nature of the condition and the character of the operation.

(2) Where the operation is of the character of a nephrotomy, dependent upon some cystic or suppurative process, the lumbar is the preferable incision.

(3) Whenever the lumbar incision becomes insufficient the space can be enlarged by another incision in a horizontal manner after the precepts of König, or as recommended by Newman.

(4) Unless specially contraindicated by reason of sepsis or other valid causes the abdominal incision should be preferred.

(5) "Early diagnosis and successful treatment go hand in hand." (Newman.)

(6) Procrastination means untold suffering to the individual and the steady increase of the dangers militating against the ultimate success of the operation.

(7) The renal artery can safely and successfully be compressed, rendering not only the operative field bloodless, but adding to the thoroughness of the operation and the chances of its success.

(8) The closure of the wound, unless contraindicated by drainage, should be preceded by a careful irrigation of the pelvis and a thorough removal of all blood clots.

(9) Whenever practicable, an incision through the kidney substance should be given the preference over one performed through its pelvis.

(10) The bottom of a renal incision should be approximated through deep sutures while the superficial edges are united by a separate row of superficial stitches.

(11) If the kidney has been much disturbed it should be stitched *in situ*. (Jacobson.)

(12) In anchoring a floating kidney it should be replaced as nearly as possible in its natural location.

(13) In a dog the implantation of the kidney between the transversalis and internal oblique muscles is a practicable and feasible step.

(14) In such an instance changes in the organ thus submitted are not sufficient to have any practical bearing upon the success of the procedure.

(15) The feasibility of a somewhat similar step in the human subject is questionable.

